VOLUME FOUR

HINTS & KINKS

for the Radio Amateur

. . . . . A Symposium of 222 Practical Ideas for the Workshop and Station Plus War-Surplus Conversion Section

$1

Published by the AMERICAN RADIO RELAY LEAGUE • West Hartford, Conn.

VOLUME FOUR

HINTS & KINKS

for the Radio Amateur

. . . . . A Symposium of 222 Practical Ideas for the Workshop and Station Plus War-Surplus Conversion Section

PUBLISHED BY

THE AMERICAN RADIO RELAY LEAGUE, INC.

WEST HARTFORD 7, CONNECTICUT, U.S.A.

1949

Volume Four of Publication No. 10 of the American Radio Relay League.

Printed in U.S.A.
First printing, October, 1949.

PRICE $1.00, POSTPAID

Volumes One, Two and Three of this publication are now out of print.

Foreword

THE SUCCESSFUL RADIO AMATEUR is, by nature, an ingenious fellow. Without a high order of resourcefulness and an ability to improvise he could never overcome the ever-present problem of inadequate workshop equipment and the equally common handicaps of insufficient apparatus and money. Evidence of this inherent ingenuity is to be seen on all sides. One cannot visit any good amateur station without finding clever improvisations, either in the construction of individual components or in the manner in which the whole station is assembled. It may be just a different way to mount a coil, or a scheme for getting a broken antenna halyard back upon the mast, or a fabulous remote-control system. Whatever the idea, it is invariably of value to the rest of us.

With the object of putting the best of these "brain storms" into circulation there has appeared in *QST*, these many years, a department devoted to the general subject of "Hints and Kinks." This department has enjoyed great popularity. The ideas contributed to it by ingenious amateurs have helped us all in our search for ways and means to improve our equipment. Unfortunately this garnered gold of amateur experimentation often has been lost to sight, shadowed by some big article or forgotten in the excitement of some major development. Then, too, there has been the annoying business of vaguely remembering a squib bearing on the problem at hand but being unable to locate it when it is most needed.

These factors led us, in May, 1933, to publish a collection of the best ideas, schemes and methods offered by *QST* contributors during the three years prior to that date. The first edition of *Hints and Kinks* was well received and established definitely the value of a single grouping of selected "experimental expedients," carefully classified and arranged. In 1937 a second volume of *Hints and Kinks* was published, containing a larger and more comprehensive collection of newer ideas culled from the offerings of *QST* contributors in the period 1934–1937. The success of this second edition motivated the publishing of an equally-popular third volume, which appeared in May of 1945.

Since the war amateur technique has been materially refined and much development of newer tubes, circuits and constructional techniques has occurred. Additionally, amateurs have found wide application in their stations for the large variety of war surplus equipment which has made its appearance. These trends, of course, have been faithfully recorded in postwar *QSTs*. Accordingly, this fourth volume of *Hints and Kinks* has been assembled to correlate the best of the postwar ideas. Much of the material has appeared in the "Hints and Kinks" and "Surplus Corner" departments of *QST*. Some of it has been gleaned from larger articles where it was doubtless lost to the view of many. Arranged in its present form, the material should constitute a potent help both in new construction and conversion. It should suggest many intriguing possibilities for putting back to work older apparatus or surplus gear now gathering dust in cellars and attics. Above all, it should enable each of us, in one way or another, to increase the efficiency of our present-day stations.

We express our thanks to those amateurs whose willingness to offer the result of their efforts to the fraternity as a whole has made this publication possible.

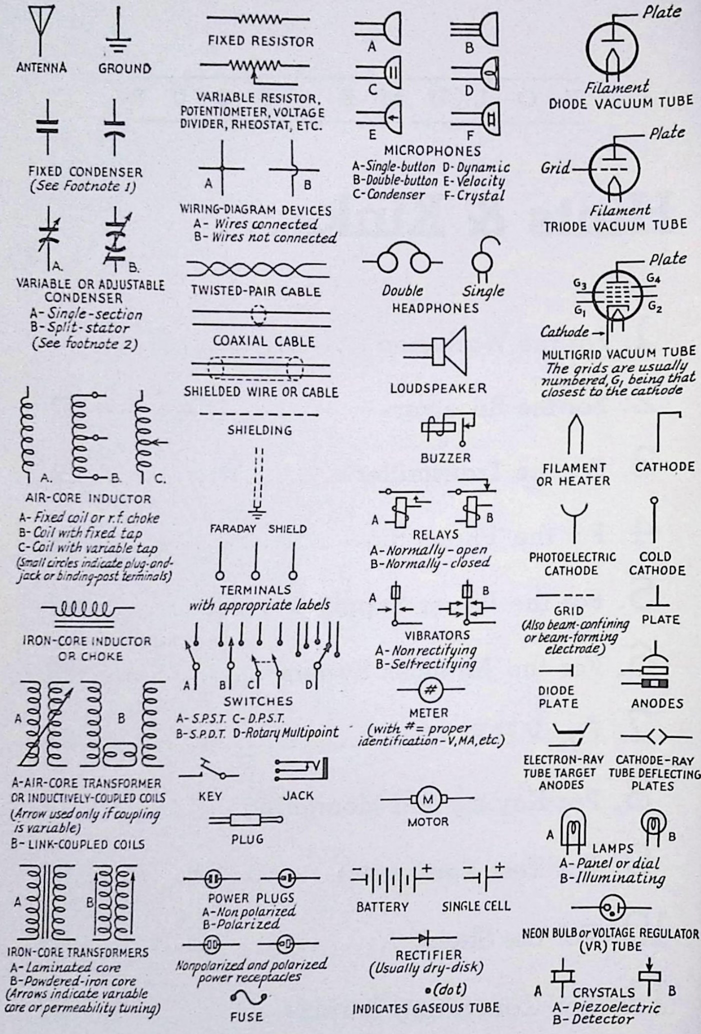
A. L. BUDLONG,
Managing Secretary, A.R.R.L.

West Hartford, Conn.
October 1, 1949

VOLUME FOUR

Hints & Kinks . . .

SCHEMATIC SYMBOLS USED IN CIRCUIT DIAGRAMS



[1] Where it is necessary or desirable to identify the electrodes, the curved element represents the *outside* electrode (marked "outside foil," "ground," etc.) in fixed paper- and ceramic-dielectric condensers, and the *negative* electrode in electrolytic condensers.

[2] In the modern symbol, the curved line indicates the moving element (rotor plates) in variable and adjustable air- or mica-dielectric condensers.

In the case of switches, jacks, relays, etc., only the basic combinations are shown. Any combination of these symbols may be assembled as required, following the elementary forms shown.

1. Hints and Kinks . . . for the Workshop

SCREWDRIVER — MINIATURE STYLE

HAVE you ever had a sudden need for a really small screwdriver . . . one that can be used in those tight spots that always manage to show up at the worst times? Fig. 1-1 shows how to make your own.

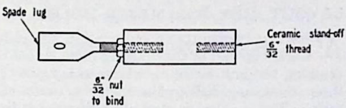


Fig. 1-1 — A "pee-wee" screwdriver that you can make from parts out of your junk box. It's just right for getting into those tight corners.

A small ceramic stand-off insulator becomes the handle, and a spade lug is threaded into one end to make the blade. Then all you need is a nut to lock things in place, and the handy gadget is complete.

— *Mel Dunbrack, W1BHD*

TAPPING MINIATURE COILS

IT is always difficult to make a movable tap arrangement for small coils such as the National AR series, where the turns are so close together that almost any of the usual clip arrangements merely short out several adjacent turns.

This problem can be solved easily by using a shortened bobby pin "swiped" from the XYL's dresser. Cut off all but the last "wiggle," clean the enamel off, and solder a flexible lead to the top. This gadget makes a swell movable tap that will fit between the turns of any of the small coils, and will make a good contact without shorting turns.

— *Don Geary, VE3BTS*

A TIMESAVING IDEA FOR COIL CONSTRUCTORS

I HAVE found a simple way to assemble coils or adapters using coil forms or tube bases. I cut the lead for the No. 1 pin about one inch longer than required, then cut each following lead about one half inch longer than the one preceding it. This makes it easier to assemble the unit. After the wires are put through the pins, they are pulled tight, soldered, and then cut off.

— *Fred C. Barker*

CONVENIENT TIE-POINT SUBSTITUTE

MANY times it proves inconvenient to mount a tie point inside a chassis at a place where several components have a common junction point. This is especially true in experimental work where it may be found necessary to add components for which no mounting provisions could be made in advance planning. A simple, yet rugged, substitute can be made by forming a few inches of uninsulated small-gauge wire, such as No. 20, into a coil as shown in Fig. 1-2, and inserting the leads from the components involved. Solder is flowed in around the "coil" which then becomes a joint that is solid enough to be permanent. If

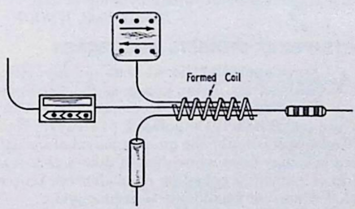


Fig. 1-2 — A simple way of making a neat connection out of what might otherwise look like a rat's nest.

later changes are found to be required, the component involved can be disconnected by simply pulling it out of the coil while heat is being applied to the joint. The inside diameter of the coil can be made large or small, depending upon the number of leads to be joined.

TOOL FOR FORMING WIRE LOOPS

HERE's a handy tool for forming loops of wire to fit over meter studs or bolts. Take a screwdriver having a tapered shank and grind or file off the blade or bit of the screwdriver. If the

shank is not tapered sufficiently, cut it down until you have a round tool, shown in Fig. 1-3, slightly larger than the diameter of the studs to be fitted with loops. (A tapered shank permits the forming of various sizes of loops; thus one tool will take the place of several.)

Fig. 1-3 — An easily-made tool for forming wire loops.

Now, by grasping the end of the wire with a pair of long-nose pliers, you can wrap the wire around the tool. A little practice using scrap wire will result in a neat, professional-looking loop.

— *Bert Felsburg*

TWO USES FOR BLOWN FUSES

THE life of small glass cartridge-type fuses does not need to end when the fuse element blows. They make excellent forms for small v.h.f. chokes, and when pigtail leads are soldered to the ends, they can be mounted firmly the same as a resistor or condenser.

— *J. C. Nelson, W2FW*

THE need for an insulated coupling device to tune small condensers in v.h.f. gear can sometimes be filled by using a blown glass-cartridge fuse. The diameter of many of these fuses is ¼ inch, making them a "natural" for use with the usual tuning condenser. The fuse can be attached to the shaft by soldering the metal tip to the end of the condenser shaft. This method is ideal for use with the many screwdriver-adjusted padder condensers that are so plentiful in surplus gear but which are often unusable because of the lack of suitable means of tuning by knob or dial.

— *Harold Held, W9OCK*

STRIPPING CHASSIS AND WIRES

A "NON-CREEPING" liquid that quickly strips finishes from metal, known as Fidelity Stripper No. 306, has been developed by Fidelity Chemical Products Corporation of Newark, N. J. Made especially for the quick removal of insulating coatings from wires, it also does a thorough job of removing baked-on enamels from objects that cannot or should not be submerged.

The liquid stripper is applied by brush at room temperature. Usually in less than a minute it causes the finish to puff and leave the metal, which is then wiped clean. Since there is no residue or corrosive action, the stripped part may be soldered or refinished immediately.

CUTTING SHEET ALUMINUM

WHILE I was butchering away on some heavy-gauge aluminum, W8INL suggested that I throw the hack saw out the window and use a carpenter's crosscut saw. With considerable misgiving, I gave it a try, and discovered that it really does work. Naturally, any carpenter will froth at the mouth at such a ghastly procedure, but what ham uses anything as it should be used? Using the saw on aluminum will not ruin it permanently, although it will probably dull faster than in wood. It does, however, speed up work in aluminum, gives a much straighter cut, and allows a long cut to be made.

— *Bill Wildenhein, W8YFB*

MAKING CUT-OUTS IN STEEL CHASSIS AND PANELS

IT is often necessary or desirable to alter a manufactured unit, using odd-shaped holes and brackets for parts mounting. In any metal under 1/16 inch thick, holes are best cut with a sharp cold chisel and a metal backing plate. For metal thicker than this, it is often necessary to drill holes around the outline, knock out the metal with a small chisel, and file around the edges. An even better method, where a small power-driven jig saw is available, is to drill one hole, slip the blade through, and saw the desired outline. Believe it or not, an ordinary run-of-the-dime-store three-for-a-nickel jig-saw blade is good for cutting a 2-inch meter hole in ⅛-inch steel panel!

— *John Alvin Weber, W5JJL*

LAYOUT KINK FOR METER HOLES

A PROBLEM frequently encountered in the radio workshop and in the drafting room is that of drawing the bolt circle on which to lay out the three mounting holes of a meter or a special socket. The problem is that of finding the radius of the bolt circle to be drawn. The following method provides an easy solution when the three holes are equally spaced:

First, measure the center-to-center distance

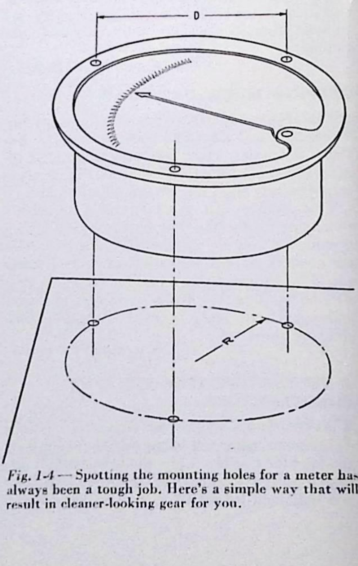


Fig. 1-4 — Spotting the mounting holes for a meter has always been a tough job. Here's a simple way that will result in cleaner-looking gear for you.

between mounting holes. This is the distance *D* in Fig. 1-4. Then multiply this distance by 0.577, which is actually two-thirds of the cosine of 30 degrees. The result is the radius of the desired circle.

— *George L. Downs, W1CT*

CONNECTOR FOR TWIN-LEAD

The small FT-243 crystal holders that are available in the present surplus market make neat and inexpensive plugs for use with almost any small-diameter two-wire cable, such as the

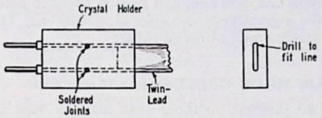


Fig. 1-5 — Efficient connector for small two-wire cable made from an old FT-243 crystal holder.

75-, 150- and 300-ohm Twin-Lead, as shown in Fig. 1-5. The holders fit the new ceramic crystal sockets, and make convenient connectors for coupling links and antenna input connections.

— *James A. Gundry, W8KNP, ex-KA1AA*

INEXPENSIVE MOUNTING FEET

A short length of ½-inch rubber tubing, available in almost any hardware store, may be used to provide cheap mounting feet for the usual steel chassis used in ham construction. Cut the tubing into four pieces, and then slit each piece lengthwise. Slip one piece on each corner of the chassis. The feet will prevent the chassis from scratching the furniture, and if you're afraid of scratching the chassis when you have it on the bench for testing or repair, a set of "feet" can be kept handy to be slipped on until the chassis is returned to the rack.

— *J. C. Nelson, W2FW*

MAKING OUT COLOR CODE ON OLD MICA CONDENSERS

Old mica condensers on which the color code is faded, scorched, or just plain dirty, will show their original identifying colors if a drop of water is placed on each spot of paint.

— *Thomas E. G. Abbott, W5DTJ*

PERFORATED METAL SHEETING

The perforated metal used in some types of acoustic ceilings is readily adapted to other uses around the ham shack. It can be used as a 'speaker grill, as protection over ventilation openings, as barriers over high-voltage bleeders, rectifier tubes or filter components.

The metal sheet is easily cut to the desired size with tin snips and can also be bent to the required shape without difficulty.

Scrap pieces can usually be obtained without cost from contractors engaged in acoustical treatment of buildings.

— *William G. Walker*

A SOURCE OF ALUMINUM STOCK

Heavy sheet aluminum may be inexpensively obtained from broadcast studios. Aluminum-base records and transcriptions are usually available at broadcast studios as they clear out their files of old transcriptions regularly.

The acetate or "Q" coating on the aluminum base may be easily removed by boiling the disks in water and peeling off the coating while the disks are still hot.

The 16-inch transcription disks will provide material for many uses around the ham shack.

— *Paul M. Bossoletti, WØGZD*

STORING PAINT

Proper storage of leftover paint represents a big saving if much work is done. If the can is over half full, put the lid on tightly, turn the can over a minute, then turn it back and put it away. This leaves a thin film of paint around the top which dries and keeps scum from forming in the can. If the can is less than half full, there is enough air in the can, even with the lid on, to form a scum. In this case, carefully pour a little thinner over the top of the paint and then close the can and put it away. In case scum forms, pouring the paint through cheesecloth will get rid of the lumps. (This is hard to do with fast-drying lacquers, however.)

— *John Alvin Weber, W5JJL*

A UNIQUE COUPLING

This device permits placement of the shaft of a variable condenser parallel with the panel and yet allows it to be turned by a front-panel dial in the usual manner.

The drawings and photograph (Figs. 1-6, 1-7) depict a 90-degree coupling. However, any angle

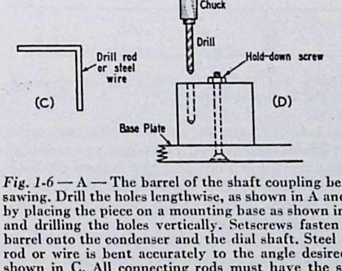


Fig. 1-6 — A — The barrel of the shaft coupling before sawing. Drill the holes lengthwise, as shown in A and B, by placing the piece on a mounting base as shown in D, and drilling the holes vertically. Setscrews fasten the barrel onto the condenser and the dial shaft. Steel drill rod or wire is bent accurately to the angle desired as shown in C. All connecting rods must have the same angle for smooth operation of the coupling. A drop of oil should be placed in each hole when assembled.

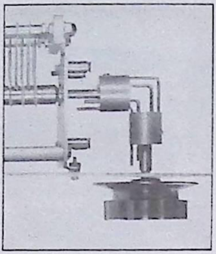


Fig. 1-7 — The homebuilt coupling when assembled.

up to 90 degrees can be provided for, if the steel rods are bent accurately to the desired angle.

The coupling may be made from brass or steel and if insulation is desired, from bakelite. However, in the latter case a coupling of sufficient size should be used to allow for adequate separation between connecting rods.

The coupling may be any size desired, and the length should be about one inch, for convenience in drilling.

— *Isaac L. Newton, VE3ACW*

JIG FOR CENTERING HOLES IN SHAFTS OR SCREWS

Many times I have tried to drill a hole in the end of a screw or a volume-control shaft, but I always have had difficulty centering the hole. I finally devised a jig which permits the drilling of an accurately-placed centering or starting hole.

The jig, shown in Fig. 1-8, consists of a piece of soft iron, or brass, about one by three inches and one-half inch thick. I first drilled three holes clear through the block using a No. 40 drill. One

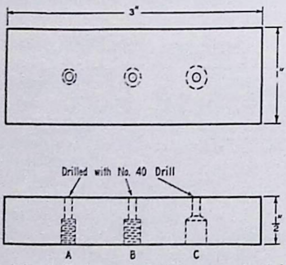


Fig. 1-8 — A jig for use in drilling a centering hole in the end of a screw or shaft.

of the holes, *A*, was then redrilled halfway with a No. 35 drill and tapped for 6-32; *B* was redrilled halfway with a No. 29 drill and tapped for 8-32 thread. The third hole, *C*, was redrilled halfway with a ¼-inch drill to accept the standard-sized shafts of variable controls.

The small holes serve as guides for a small drill which will make a centering or guide hole in the end of the screw or shaft.

— *Felix W. Mullings*

STENCILLING NAMEPLATES

There are many stencils and "decals" on the market for ham use, but all of them lack one thing or another. Either they are not the right color, not the desired type style, or not the right inscription to do the whole job. You can make your own very simply with a typewriter and a mimeograph stencil.

Type the desired wording on the stencil, and then cut it into small strips. Place the strip on the panel, hold it firmly against the surface, and rub some thick paint over it with your finger. Rub only in one direction, and be sure that the paint is the approximate consistency of vaseline. The results are well worth the effort.

— *C. Harvey Haas, W6EAH*

HAM-MADE CABLE-LEAD MARKERS

Two different methods that may be used to mark leads fanned out from a multiwire cable are shown in Fig. 1-9. In A, a small paper marker

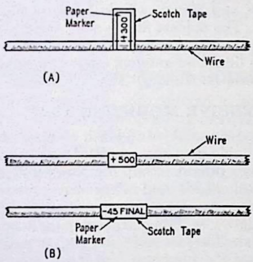


Fig. 1-9 — Two methods of marking cable leads. The tab type shown in A is suitable for leads that are infrequently handled. The wrap-around type in B may be handled without danger of tearing.

is protected by a piece of Scotch Tape that encircles the lead and is pinched together on both sides of the identifying marker.

In B, the marker is wrapped around the lead and then a piece of Scotch Tape is wound around the lead over the marker, thus protecting it from being defaced or torn off.

— *J. C. Nelson, W2FW*

SOCKET HOLES IN BAKELITE

A neat, workmanlike job of making socket holes in bakelite can be accomplished with a Greenlee socket punch. Use the tool in the same manner as for cutting metal chassis.

— *Earl F. Hart*

TIPS ON CLEANING CRYSTALS

Undoubtedly there is hardly an amateur who has not removed the crystal from his transmitter and taken the holder apart for some reason or other. Usually it was because the crystal did not operate properly. The remedy was to wash the crystal with carbon tetrachloride or another cleaning fluid. Nine times out of ten,

the rig would then operate correctly and everyone was happy for a few months until the action had to be repeated.

However, during and since the war techniques in the manufacture of quartz crystals for frequency stabilization have changed tremendously, and there will be relatively little need for cleaning a crystal made in these years.

It was learned during the war that crystals changed frequency while resting on the shelves awaiting shipment. The ultimate solution of the fault was to eliminate the use of abrasives as well as carbon tetrachloride in the final finishing. It was observed that abrasives left a broken surface which rearranged itself constantly, and that carbon tetrachloride left a residue which was detrimental to the oscillating qualities of the crystal. Thus was adopted the acid-etch or fluoric-etch process to finish the crystals, plus the use of warm water and soap to keep them clean. The result is that now, with the use of air-tight and hermetically-sealed holders, it is not necessary or even possible to remove the blank!

If you do happen to have a prewar crystal and it does need cleaning, do it in the following manner: Lay the crystal on a piece of clean cheesecloth or kitchen toweling, and, using a toothbrush, white castile soap and warm water, scrub both sides of the blank carefully. Then rinse in clean water and make absolutely sure that the crystal is free from all soap and dirt. Rest the crystal on edge and let dry. While it is drying, wash the crystal electrodes in the same manner, and blow all of the dust and residue from the holder, being careful not to get any moisture in the holder. After everything is dry reassemble the works. Cleanliness is an important factor, so keep your fingers off the surface of the crystal and electrodes. If you take the extra precaution of sealing the top carefully with shellac, you will probably never have to take the holder apart again.

— *H. Edwin Dorr*

CRYSTAL-GRINDING COMPOUND

ANYONE interested in good fast-cutting and easy-to-obtain crystal-grinding abrasive should try ordinary automobile valve-grinding compound.

The writer has been using it very successfully to grind 160-meter crystals to the 80-meter band. The grinding operation takes about twenty minutes.

— *Louis D. Breetz, W8QLP*

BEAM-HARDWARE CONSIDERATIONS

THE natural tendency for most of us is to use durable material when building beam antennas. Thus we think first of brass screws and hardware, because of their weather-resistant qualities. What we forget, however, is that when two dissimilar metals, such as aluminum and brass, or copper, are in contact in the presence of moisture, electrochemical action takes place and sooner or later something has to break loose. If, therefore, you plan to use aluminum tubing for your beam elements, round up some aluminum nuts and bolts to go with it. Stainless-steel hardware may also be used with safety. Most large hardware stores have such things in stock.

— *Joseph Engels*

— • • • —

IF you're searching for strap-iron "U" brackets to brace that new antenna boom or mast, contact your local railroad signal depot and get permission to look over their scrap heap. W2VP found just what he needed on such a jaunt — discarded pipe-line hangers that fit a 2 × 4 snugly.

R.M.A. COLOR CODE FOR MULTIWIRE CABLES

INSTEAD of keeping elaborate records of the colors of wires and the terminals used in a multiconductor cable hook-up, I hit on the idea of using the well-known RMA color code for this purpose. This new system works exceedingly well. Fig. 1-10 shows the basic idea. It will be

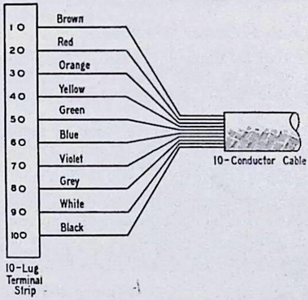


Fig. 1-10 — Using the RMA color code to terminate multiconductor cables.

noted that the terminals are numbered from top to bottom (or left to right), with No. 1 at the top or left. The colors start brown, red, orange, etc. Wire No. 11 would be brown with a brown-and-white tracer. Wire No. 12 would be brown with a red tracer. This system proved extremely useful in connecting up 127 thermocouple gauges in a special job.

— *Dwight Stebbins*

HINT FOR DECAL USERS

WHILE the Millen panel-marking "decals" work well on almost all finishes, difficulty is sometimes experienced where a poor grade of lacquer has been used in painting the panel. The solution supplied with the decals acts almost like a paint remover with the cheap lacquer, ruins the finish, and makes application of lettering impossible.

A sure remedy is to apply a small layer of white shellac with a camel's-hair brush over the spot where the decal is to be placed. In five or ten minutes the shellac will be dry enough to permit application of the decal in the usual manner.

Shellac can also be applied to bare metal surfaces such as bakelite, metal, or fiber, allowing decals to be placed on these surfaces as easily as they are on painted surfaces.

— *William J. Kuehl, W9VQX*

SIMPLIFIED METHOD FOR CALCULATING *L* AND C ON THE SLIDE RULE

HERE is an easy way to find inductance and capacity values on a slide rule, requiring only one setting of the slide.

The formulas used are as follows:

$$f \text{ in cycles} = \frac{1}{2\pi\sqrt{LC}} \text{ when } L \text{ is in henrys, } C \text{ in farads.}$$

$$f \text{ in Mc.} = \frac{159}{\sqrt{LC}} \text{ when } L \text{ is in } \mu\text{h., } C \text{ in } \mu\mu\text{fd.}$$

$$\text{Therefore, } f\sqrt{LC} = 159;\ LC = \left(\frac{159}{f}\right)^2, \text{ when } f \text{ is in Mc.}$$

To find *LC* for, say, 7.3 Mc. on the slide rule, first set 7.3 on Scale C above 159 on Scale D. Then read the *LC* value on Scale A — in this case 475.

If *L* is given, *C* may be found by setting its value on Scale B under the *LC* value. The reading appearing on Scale *A* over the index (1) on Scale B will be the value of *C*.

This method may be used for cycles, kilocycles or megacycles, farads, microfarads or micromicrofarads, henrys or microhenrys, when the correct placing of the decimal point is mentally calculated.

— *Murray MacKenzie*

POINTERS FOR BETTER SOLDERING JOBS

A GOOD way of eliminating the messy stains on soldered joints has been turned up by W1JEQ. As soon as the solder has "set," but while the joint is still hot enough for the rosin to be in a semiliquid state, he brushes the surplus rosin away with a small fairly-stiff brush. This leaves the joint shining and clean. The rosin hardens on the brush and is easily removed by flexing the bristles with the fingers.

—···—

ONE of the most annoying temper-raising finger-burning operations in rig building is the holding of small parts in cramped places while soldering. These headaches can be completely done away with by the use of a surgeon's Hemostat, which can be purchased for about a dollar at any second-hand medical supply store. This handy gadget looks like a pair of scissors but actually has jaws similar to long-nosed pliers. The big feature of the tool is a ratchet-like catch incorporated between the handles, so that once that elusive 100-$\mu\mu$fd. mica has been caught in the jaws, the handles may be snapped together to hold the condenser fast. When so held, it can be maneuvered into soldering position with the Hemostat and kept rigid during the process. The fingers also are at a safe distance, and a better connection results in every way.

— *H. F. Shepherd, jr., W6QJW*

—···—

WHEN you are stripping some gear and want to be able to use the parts again in another rig, damage to the fragile socket pins can be avoided easily by plugging an old tube in the socket while you unsolder the connections. The pressure of the tube pins against the socket terminals keeps them straight, and prevents bending and loosening.

— *David O. Finnell, W5LCL*

—···—

ON THOSE hard-to-solder jobs, where the iron is too small for the job at hand, try preheating the metal parts to be soldered with an electric hot plate, toaster, or other source of heat. The iron will not then have to lose so much heat, and the operation can be performed successfully.

— *J. C. Nelson, W2FW*

HAM-MADE SOLDER FLUX

AN EXCELLENT noncorrosive soldering flux can be made by crushing rosin into a fine powder, then mixing it with methyl hydrate or rubbing alcohol until a syrup about the consistency of molasses is secured. This mixture should be kept corked when not in use. However, I have found that the alcohol does not evaporate rapidly when mixed with rosin. A 1-oz. bottle of this flux will last a long time, so it is very inexpensive.

— *Austin A. Smith*

SOLDERING-IRON CLEANER

SHOWN in Fig. 1-11 is a handy tip cleaner for your soldering iron. It is made from an empty solder spool, forming two "cups" by sawing it in half through the barrel of the spool. The cups are then filled with steel wool, and are fastened to the

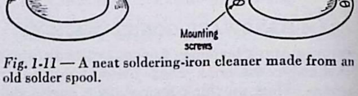


Fig. 1-11 — A neat soldering-iron cleaner made from an old solder spool.

work bench by two screws that pass through the large flange. Just a poke and a twist of the iron into one of the cups will insure a clean, bright iron and greatly simplify the soldering job. In my own shop I found the vertical back of the bench the most useful spot for mounting these gadgets.

— *Leon Baldwin, VE2TM*

SOLDERING IN CRAMPED QUARTERS

Recently having a soldered connection come loose deep inside a milliammeter, and not wishing to take time or risk further damage to the instrument by taking it apart, I resorted to the stunt illustrated in Fig. 1-12. It is a simple method that will prove helpful whenever it becomes necessary to make a soldered connection in a space too small for the point of the soldering iron to enter.

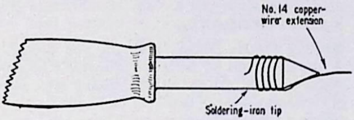


Fig. 1-12 — **A handy "extension" for soldering in close quarters may be made of a short length of No. 14 copper wire, preferably pretinned.**

A short length of No. 14 bare copper wire is wrapped about three turns around the tip of the iron, with an extension brought out as far as needed past the tip of the iron. The "extension" works best with pretinned copper wire, but any metal that will conduct the heat will do. Have the extension contact the tip of the iron along as much of its length as possible.

— *Jerry Morgan, W5ABQ*

GLYPTAL SOLVENTS

Cliff Erickson, W8DAE, finds ordinary paint remover a highly effective agent for loosening Glyptal-locked bolts and nuts. A more adventurous soul, Wayne R. Ayres, W9PAB, uses his XYL's fingernail-polish remover for doing the job!

— • • • —

Glyptal can be *temporarily* softened by the application of heat, a heavy-duty soldering iron being a good source. However, fast work is necessary once a setscrew or coupling has been freed in this manner, because the stuff "sets up" rapidly.

— *W4JWG*

HANDY FEED-THROUGHS

Excellent high-voltage feed-through grommets can easily be made by cutting wafer-shaped cross-sections of the vinylite dielectric used in coaxial cables.

— *W6EFH*

EQUIPMENT NAMEPLATES FROM HAND-DRAWN NEGATIVES

White-on-black paper nameplates are suitable for use on transmitter, receiver, frequency-meter and other instrument panels. Obviously, they are best applied in the case of equipment having a black panel or cabinet.

A negative is made of tracing paper. The printing may be either typewritten or hand-lettered on the negative. If typewriting is to be used, the type should be cleaned with a small brush and carbon tetrachloride, and a dense and fairly new ribbon used. The tracing paper should be backed with a piece of carbon paper (carbon side facing tracing paper). Hand lettering should be done with black drawing ink. Border and other lines should be drawn with drawing ink and a ruling pen. Slightly sharper lines will result on the finished job if the lines are drawn on the reverse side of the negative — i.e., the side that will be next to the sensitized paper.

Photographic paper is then exposed through this negative, and developed and fixed in the usual way. A double-weight paper stock with a velvet surface is suggested and should be the "hardest" available; e.g., Azo No. 5. The time of exposure is not critical, and with an ordinary printing box, 10 seconds will be about correct.

— *Earl Schoenfeld*

— • • • —

Of interest to amateurs who don't own photographic equipment is the following method of blueprinting nameplates, suggested by Charles F. McMorrow, W1KLN:

The nameplates are drawn with black drawing ink on pure white paper, then taken to a blueprint maker and photostated. Care must be taken in cleaning the original drawing since the photostat will show dirt marks as well as the drawing. These prints turn out very well and are glued right to the panel with any good grade of glue, or they can be glued to a thin sheet of brass to make the usual type of removable nameplate. The background of the print is more gray than black, and looks well on either gray or black panels. After the glue has dried, the surface of the print is given a coat of lacquer (clear fingernail polish), and when dry will remain new-looking for a long time.

A word about the cost. An $8\frac{1}{2} \times 11$-inch drawing will hold about 12 switchplates or about 70 small one-line nameplates ($1\frac{1}{2} \times \frac{1}{2}$ inch), and costs 30 cents to photostat.

It pays to *make* your own and have just the wording you want and any design you want. Of course your own labor comes cheap, and a bottle of glue will last a long time.

PADDING FOR 'SPEAKER CABINETS

In case you're in need of a suitable absorbent padding material to deaden a loudspeaker cabinet — especially the bass-reflex type — a satisfactory substitute will be found in "Chux," a disposable baby diaper, available at the corner drugstore in case you have no little harmonics at your house.

— *W5CVO/4*

DRILLING GLASS PANES

A simple way to drill a hole in a pane of glass is to use an old drill (that you have no further use for) and a high-speed electric drill. Place the glass on an absolutely flat surface, and turn on the drill, applying moderate pressure. After a time, the drill will become red hot, and then almost white hot. Suddenly it will fall right through as it

melts the glass. Do not try to take the drill out while it is still turning, but turn it off, removing it from the hole before the glass has had a chance to cool. The drill will be no good for drilling metal, or even wood, after use in this fashion, but it may be used on glass again. There will be a slight burr around the edges of the hole when it hardens, but this is usually of small consequence, and can be covered by a beehive or other type feed-through insulator.

— J. A. Felthouse, KL7ED

ANOTHER GLASS-DRILLING HINT

Here's another way to drill glass, and it's probably the best way if you have access to a drill press. If you don't have a drill press, you will have to use another method.

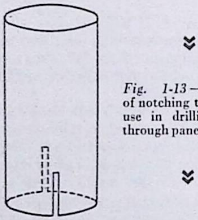


Fig. 1-13 — Method of notching tubing for use in drilling holes through panes of glass.

Determine what diameter hole you want and obtain a piece of thin-wall brass or copper tubing of the same outside diameter. With a suitable saw notch the tubing as shown in the diagram, and mount the tubing in the drill-press chuck. If the tubing is of a larger size than the chuck capacity it will be necessary to devise some sort of a holder. One way is to shape a wooden dowel of hard wood, one end of which will fit in the chuck and the other end of which will fit inside the tubing. A screw can be run through the tubing into the wood to hold it firmly in place. It is essential that the tubing run true on the axis of rotation, with no wobble or shifting.

The glass through which the hole is to be drilled should have a firm foundation on the drill-press bed. When drilling thick glass sheets a wood base is often used. However, for drilling such thin panes as window glass, it is strongly recommended that a layer of soft felt be placed under the glass.

A dam of putty or plaster of Paris is built up around the hole-to-be, and this is then filled with a mixture of water and Carborundum. Or, if no Carborundum is immediately available in the workshop, fine valve-grinding compound may be used.

Now you're all set to drill. The watchword is "take it easy." Don't use too much pressure, don't try to go too fast, don't try to force the operation. Use very light pressure, just enough so that the felt begins to give. After you've drilled through a couple of panes of glass (and have perhaps broken one) you'll get the "feel" of it. It is essential that the grinding compound stay moist and fluid. Some of the water will pass through the slots in the tubing to the inside of the spot being drilled, thus keeping that area cooled. If not, there'll be a hot spot, and a good chance that the glass will crack.

Keep plenty of water on the work and not too much pressure on the drill press, and you won't have any trouble. Coarse Carborundum will cut faster than fine powder or valve-grinding compound, but the hole won't be quite as smooth.

— Richard L. Baldwin, W1IKE

A BATTERY-SAVER

If you are like most amateurs, you probably run a big bill for batteries principally because you neglect to turn the switch off after some piece of incidental gear is used. By employing a timer switch made for gas-engine model aircraft, I really saved on batteries and cuss words. The switch can be adjusted for a 5- to 10-minute period, and then wired in series with the usual filament switch. The price is reasonable and the timer surely pays for itself in saving batteries, which come rather high these days.

— B. E. Henry, W8QBJ

GETTING AT THAT CRAMPED SPOT

Here's an old trick that still works . . . it might save *you* a bit of bother. Did you ever try to put a 6-32 nut into a spot where your fingers or your "long-noses" wouldn't go? Just take a short length of solder, flatten the end a bit, and force it part way into the nut threads. Bend the solder into the form necessary to get down to that inaccessible bolt, and there you have it. Now all you have to do is to get at the bolt head with a screwdriver! If you can't do that — you had better move the whole works.

— R. O. Deck, jr., W9JVI

USEFUL TOOL FOR TVI REDUCTION

When you start working on your rig to cut down harmonic radiation, you'll find the gadget illustrated in Fig. 1-14 a handy addition to your bag of tricks. It is a pick-up loop designed to permit easy and constant coupling to d.c. leads, feeders, tank coils, etc., to make your indicator a more useful and reliable device.

An 8-inch length of the new tubular 300-ohm Twin-Lead is used to form a hairpin loop. The wires at one end of the piece are joined, forming the loop, and a convenient length of 75- or 150-ohm Twin-Lead is connected to the other end, running to a single-turn loop that fits around the coil in your harmonic indicator. A 1/8-inch slot is cut through the side of the hollow Twin-Lead, as shown. The little notches near the ends of the slot permit you to clamp the lead you are checking within the "probe" so that the lead and the hairpin loop run parallel for several inches. This provides maximum coupling to the lead, and also insures that the degree of coupling will remain *constant* while you work on the rig to reduce the amplitude of the harmonic flowing in

that lead. Thus you won't have to wonder whether the "reduction" in the harmonic was a result of the change you made, or of a difference in the degree of coupling from one measurement to another.

The bare wires exposed at the joints in the probe may be insulated by melting a little of the brown dielectric from a scrap of the Twin-Lead and flowing it over the joint, as is done in making up the center joint in Twin-Lead folded dipoles. You can then use the probe around fairly high voltages without fear of electrocution. It is also possible to push the probe through small openings in the shielding of your rig to determine how much of the harmonic is still left inside. In low-power transmitters it is even possible to place the pick-up probe right inside the tank coil.

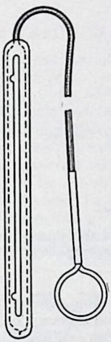


Fig. 1-14 — Handy probe for use with a wavemeter in conducting tests to reduce TVI. The construction of the probe, which is made of the new tubular Twin-Lead, is discussed in the text.

When using the slotted probe to check an open-wire feed line, bow one side of the feeder for about six inches of its length and clamp the bowed portion inside the probe. In this way you'll be able to check the effectiveness of your antenna coupler in knocking down the harmonic that gets out by way of the antenna.

The use of the pick-up loop discriminates against stray pick-up from the fundamental signal, and gives you a reading of the harmonic only. In addition, it permits you to place the indicator on the bench, freeing the hand that would otherwise hold it to make adjustments on the rig. If you've tried to maintain constant coupling to a given circuit and make adjustments on that circuit at the same time, you'll know what we mean! With this gadget it's easy.

— *Richard M. Smith, W1FTX*

TOOL FOR REPLACING METAL TUBES

A TOY "arrow" (wooden dowel with rubber suction cup at one end) is a handy gadget for replacing metal tubes in hard-to-get-at sockets. Toy stores have them at three for a dime.

— *Cliff Robinson, W1RQR*

ADAPTER FOR OCTAL-BASE RECTIFIER TUBES

HERE'S a handy idea for the workbench that permits interchange of any of the 5-volt octal-base rectifier tubes (5T4, 5U4G, 5V4G,

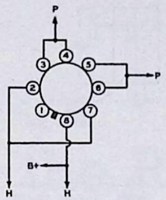


Fig. 1-15 — Jumpers added to an octal tube socket to permit use of various types of 5-volt rectifiers.

5W4, 5X4G, 5Y3G, 5Y4G or 5Z4). All that is needed is the addition of a few jumpers as shown in Fig. 1-15.

— *Ward T. Watson*

—···—

W. A. MIDCALF has tried the above hook-up and finds it most satisfactory. He cautions against the use of wafer-type sockets, which do not have the voltage-breakdown ratings of the molded bakelite or ceramic types. — *Ed.*

LIMITING DRILL TRAVEL

EVEN in the most careful designs, it is often necessary to drill an extra hole or two after some of the parts have been mounted. To keep from ventilating some of the parts with the drill, start the hole, then remove the drill and slip a metal tube or wood block of the correct size over it, as shown in Fig. 1-16, and resume drilling

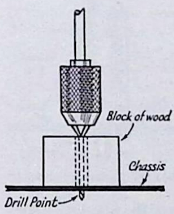


Fig. 1-16 — Method of limiting the travel of a drill to prevent damage to parts which may have been mounted underneath the chassis.

without danger of punching through. Unless an intermittent, low-resistance connection is specifically desired, it is advisable to remove the metal shavings after drilling. This is pretty hard to do unless some vaseline or cup grease to hold the chips has been spread over the point where the hole is drilled. The grease is wiped off after the drilling is complete.

— *John Alvin Weber, W5JJL*

PLUG-IN SHIELD CANS

WHILE building a new exciter, I found it necessary to shield one plug-in coil, but that meant a plug-in shield would be needed. After some thought the solution shown in Fig. 1-17 pre-

sented itself. It is passed along to others who may like to have good-looking gear but who can't afford the commercially-built refinements.

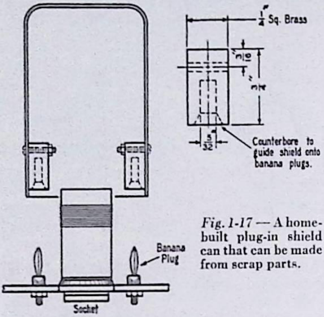


Fig. 1-17 — A home-built plug-in shield can that can be made from scrap parts.

The shield is a square aluminum coil shield from a defunct b.c. set. The two square brass pieces are drilled as shown, mounted inside the can, and the whole works then plugs onto a pair of banana pins mounted on the chassis.

— *Bill Wildenhein, W8YFB*

SHIELD FOR MINIATURE TUBES

Here is an efficient and easy-to-make tube shield for "peanut" or miniature glass tubes. As shown in Fig. 1-18, the shield is made from a short length of large-diameter copper shield braid.

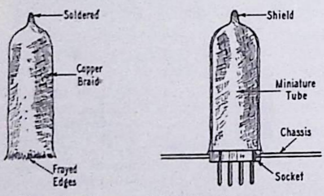


Fig. 1-18 — Improvised shield for miniature tubes.

The diameter and length of the braid are determined by the tube used, and should be chosen so as to form a tight fit over the glass envelope. Cut the length of braid about one-half inch longer than the tube, twist one end of the braid together, and solder. This makes the top of the shield. The bottom of the shield is left frayed so that there will be numerous contacts with the metal chassis. A ground wire could be added to assure permanent connection, if desired.

— *Harry Star, W1MWO*

BREADBOARD-CONSTRUCTION HINT

How to mount a toggle switch on a breadboard-construction job has been a problem that is hard to lick. They just aren't built to be mounted on a board. It can be done, however, by opening the "eye" of a ½-inch screw eye with a screwdriver blade, putting the barrel of the switch inside the eye, and then clamping it there with gas pliers. The lock nut on the switch barrel can be used to hold the switch firm, and the whole assembly can then be fastened to the breadboard by screwing the eye into the wood.

— *William J. Wright, W5KYK*

SHIELDING KINK

In some instances, such as in a high-gain audio amplifier, it is desirable to shield an individual component to reduce hum. A very effective shield can be made from the metal case of a discarded fluorescent-light "starter" by removing the glass tube and condenser found inside and mounting the component inside on the terminal lugs. The result is shown in Fig. 1-19.

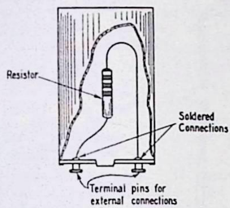


Fig. 1-19 — An effective method of shielding an individual component. The case of a burned-out fluorescent-light "starter" is used as shown.

The assembly can then be grounded to the amplifier chassis by means of a cable clamp, or by drilling a hole in the top of the can and mounting with a 6-32 screw. The outside connections can be made with shielded wire to insure complete isolation.

— *G. W. Jerguson, W4IJI*

CHASSIS-CUTTING TOOL

Aviation or "duck-bill" snips are the answer to the problem of cutting round or square holes in chassis. A ¼-inch hole is sufficient to get them started. With ordinary thicknesses of chassis material a square hole with practically no fillet can be cut easily. Likewise, round holes are a cinch. Because any size hole can be cut using this tool, it is well worth its price of approximately $4.75.

— *Lt. Cmdr. R. J. Slagle, USN, W3PD*

REMOVING GLASS FROM METER CASES

Oftentimes it becomes necessary to remove the glass face of a meter, either for repairs or for recalibrating the scale. A convenient way to do this is to bake the meter with an infrared heat lamp. This expands the bakelite or metal case but not the glass, allowing the latter to drop out "easy like."

— *Ed. A. Kirchhuber, W2KJY*

2. Hints and Kinks . . .

for the Receiver

AN UNTUNED PRESELECTOR

Although the old adage concerning the impossibility of "getting something for nothing" still holds, the addition of a simple untuned 6AC7 preselector has been found to add much to the sensitivity and selectivity of small communications receivers without a tuned r.f. stage ahead of the converter. For best results the preselector should be connected to the receiver with the antenna coil of the superhet directly in the plate circuit of the preselector, as shown in Fig. 2-1. This arrangement was found to be better than the choke-condenser coupling shown in Fig. 2-1B.

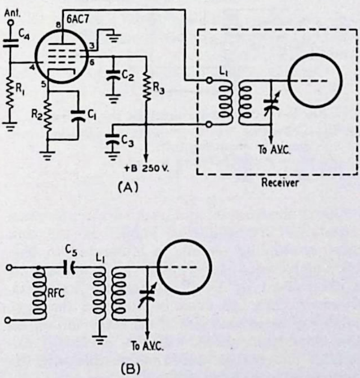


Fig. 2-1 — This untuned preselector requires only a few components and a 6AC7, yet it will improve the performance of the ordinary variety of communications receivers having no preselection. An alternate method of coupling to the receiver is shown in B where an r.f. choke replaces L_1 in the circuit shown in A and is capacity coupled to the antenna winding of the receiver.
C_1, C_5 — 0.01 μfd. paper.
C_2, C_3 — 0.1 μfd. paper.
C_4 — 47-$\mu\mu$fd. mica.
R_1 — 1 megohm.
R_2 — 220 ohms.
R_3 — 47,000 ohms.

In receivers with separate antenna coils (for use with doublet antennas) the connections are quite easily made, and even in those with internal grounds it is a simple job to unsolder the grounded end, and bring it out for use with the preselector. With such connections the reflected impedance in the plate circuit of the preselector is maximum at the frequency to which the mixer grid circuit is tuned, and therefore maximum gain is achieved at that frequency alone. The grid of the 6AC7 may be returned to the a.v.c. line if it is desired to make this additional change in receiver wiring, but it is not essential for smooth operation of the preselector.

— *Herbert L. Ley, jr.*

USING ONE RECEIVER TO CHECK I.F. OF ANOTHER

When a signal generator is not available, this simple means of lining up a receiver's i.f. amplifier may help.

The idea is to use a second receiver whose i.f. amplifier already is tuned to the desired i.f. The second receiver, used as a signal generator, is tuned to a station. The output signal then is taken from one of the i.f. stages and fed through a mica condenser to the i.f. amplifier of the first receiver. The first i.f. amplifier then can be lined up on this signal.

— *Kenneth S. Digre*

COMBINATION B.F.O. AND A.N.L. FOR THE SKY BUDDY

The combination b.f.o. and a.n.l. circuit used in the S-38 receiver can also be used in the Sky Buddy by substituting a 6SQ7 for the 76 b.f.o. tube originally used. The 76 and its socket are removed, and an octal socket for the 6SQ7 is installed in place. The circuit connections are shown in Fig. 2-2. The two diode plates are tied together and are connected to the control grid of the audio tube through a switch. The triode section of the tube is then wired as the b.f.o.

In operation no trouble has been experienced

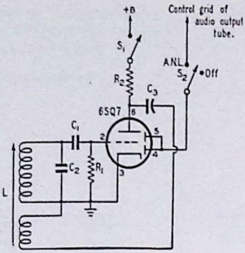


Fig. 2-2 — Circuit modifications required for the addition of a noise limiter to the Sky Buddy receiver.

C_1 — 100-$\mu\mu$fd. mica.
C_2 — 470-$\mu\mu$fd. mica.
C_3 — 0.01-μfd. 400-volt paper.
R_1, R_2 — 47,000 ohms, ½ watt.
L — B.f.o. coil.
S_1 — B.f.o. switch.
S_2 — S.p.s.t. toggle switch.

with the performance of the new b.f.o., and the limiter works very well. With the limiter switched into the circuit it is possible to hear signals plainly that were previously not even audible through the noise.

— *Fred R. Mumma, W3KEK*

A SHORT-WAVE LOOP ANTENNA

In an attempt to receive DX broadcasts originating in the U.S.A. and in London, I have been experimenting with antennas of various types in an effort to minimize interference from undesired stations operating on the same frequency. Since the local set-up makes it impossible to string up a terminated-rhombic antenna, I now use the old familiar loop, tuned to the desired short-wave band and rotated until one of the nulls is placed on the interfering station. While the performance of the loop does not compare with that of a rhombic, it does a better job of reducing interference than any other type of antenna for which space is available.

The frame consists of a wooden cross, 19 inches across by 25 inches high, on which are wound three turns of insulated No. 14 wire. The ends of the antenna are tied to the stator plates of a 35-$\mu\mu$fd. split-stator condenser. The condenser rotor and the center tap of the antenna are grounded to reduce hand capacity (and consequent change of tuning) to a minimum.

For coupling the antenna to the receiver I first tried a single turn, inductively coupled to the three-turn loop. When this turn was connected to the 600-ohm input of the receiver, the antenna tuning was affected by the tuning of the receiver. This was tried on the 9.5–11.75 Mc. short-wave broadcast band.

Next I removed the coupling loop and substituted a low-impedance match, tapping the antenna 14 inches from the center tap on each side and hooking the low-impedance leads to the receiver input. The loop was connected to about 4 feet of twisted line and mounted adjacent to the receiver.

The antenna tuning sharpened greatly and the signal strength came up to a level only one "S" point less than with a 75-foot antenna installed outside.

The results with this arrangement were startling. Tuning to London each evening on the 11.75- and 15.0-Mc. bands, I was able to keep them tuned in fine, and placing the null on the interference cut it down two or three "S" points on the receiver's meter.

— *Lt. Henry B. Plant, SC*

ANTENNA COUPLER FOR THE RECEIVER

Modern communications receivers possess different input-impedance characteristics, and receiving antennas, with their varying types of transmission lines, have different terminal impedances. Therefore it may be seen that the receiver transmission line should not necessarily be connected directly to the antenna binding posts on the receiver. An impedance mismatch will occur in many cases, and as a result, a lowered transfer of radio-frequency energy will exist between the transmission line and the receiver input circuit.

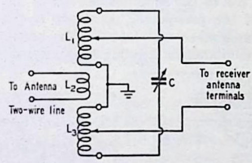


Fig. 2-3 — Antenna coupler for the receiver.

L_1, L_3 — 15 turns No. 22–24 wire, tapped, on 1-inch diameter form. See text.
L_2 — 3 turns wound between L_1 and L_3.
C — 50-$\mu\mu$fd. variable.

One of the simplest and most effective antenna impedance arrangements, known as the link antenna-coupling circuit, is illustrated in Fig. 2-3. The correct adjustment of the secondary coil is determined by the "cut and try" method. However, each tap must be adjusted the *same number of turns each side of the center tap on the coil.* Condenser tuning will give a sharper impedance match than would be possible with the tapped-coil arrangement alone.

— *Art Monsees, W6HJP*

REDUCING NO-CARRIER NOISE IN F.M. RECEIVERS

To kill noise in f.m. receivers when no carrier is being received, try adding fixed bias to the limiter tube. Sufficient bias should be used to cut the tube off, plus enough to keep the noise voltage from drawing limiter grid current.

— *Robert G. Hester*

IMPROVED "HETEROFIL" CIRCUIT

After experimenting with various suggested "Heterofil" circuits, I found that performance was greatly improved by the use of the three

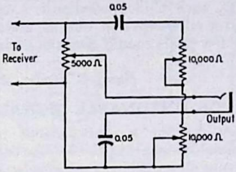


Fig. 2-4 — Improved "Heterofil" circuit developed by W7ABF. The three variable controls are not ganged.

variable controls in the circuit shown in Fig. 2-4. It is suggested that condensers of high quality be used as others will impair the operation.

— *Robert H. Flagler, W7ABF*

DIODE PEAK CLIPPER WITHOUT BIAS BATTERIES

In the course of trying several noise limiters, we attempted to use a pair of selenium rectifiers in place of the 1N34 germanium diodes called for in the *Handbook* circuit. We found that instead of clipping at the 3-volt level that was supposed to be established by the bias batteries, the unit clipped at 8 volts peak-to-peak. Apparently the 5-volt drop that is encountered in the selenium rectifiers holds even at low current levels.

The batteries were eliminated, therefore, resulting in the circuit shown in Fig. 2-5. The limiter clips at 5 volts, peak-to-peak, which has worked out well for high-impedance 'phones.

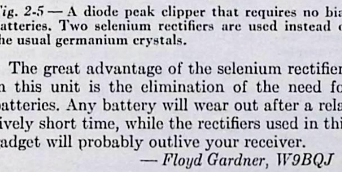


Fig. 2-5 — A diode peak clipper that requires no bias batteries. Two selenium rectifiers are used instead of the usual germanium crystals.

The great advantage of the selenium rectifiers in this unit is the elimination of the need for batteries. Any battery will wear out after a relatively short time, while the rectifiers used in this gadget will probably outlive your receiver.

— *Floyd Gardner, W9BQJ*

CAR RECEIVERS FOR MOBILE

If you are planning a mobile 3.9- or 14-Mc. 'phone station for your car but don't know what to do about a receiver/converter combination, W8MGQ reminds us that there are car radios built that include the broadcast band *and* short-wave. Some can stand a little bandspreading, but otherwise they should be a natural.

MINIATURE BASS-REFLEX CABINET

Whether it's a 3-, 4- or 5-inch 'speaker on your communications or midget broadcast receiver, the quality of reproduction will be greatly enhanced by mounting the 'speaker in a bass-reflex cabinet. A cost-free enclosure can be provided through the use of a cigar box obtained from your friend in the corner store. Cut a round hole of the proper size in the bottom of the box for the 'speaker as shown in Fig. 2-6. Then cut a rectangular aperture below the 'speaker hole. This should have an area approximately one-

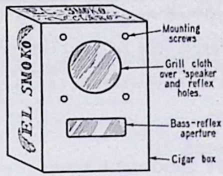


Fig. 2-6 — Cigar-box bass-reflex cabinet for a small 'speaker. The holes may be covered with cloth.

quarter that of the 'speaker opening. A small notch cut in the lid will permit the entrance of the leads. Then nail the lid tight. The improvement in quality will surprise you!

— *M. V. Winston, W2EZC*

A FORWARD-READING S-METER

Hams who build their own receivers often desire to include a carrier-level indicator in their sets. Unless one has a special meter whose normal needle position is at the right for zero current indication, the meter will read backward. This means that maximum deflection with signal applied will be to the left. In order to have the meter read to the *right* at maximum signal it is necessary to invert the instrument. This often spoils the finished appearance of the set.

The circuit shown in Fig. 2-7 overcomes this difficulty. It consists of a v.t.v.m. with a modified Wheatstone bridge in the plate circuit. Values of components may, of course, have to be altered to adapt the circuit to conditions encountered in different receivers. With the values shown the circuit will function correctly with a 250-volt d.c. plate supply and an a.v.c. system developing up to 10 volts.

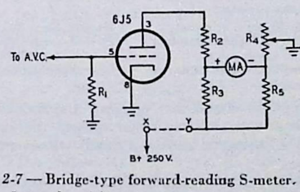


Fig. 2-7 — Bridge-type forward-reading S-meter.
R_1 — 1 megohm, ½ watt.
R_2 — 22,000 ohms, ½ watt.
R_3, R_5 — 47,000 ohms, ½ watt.
R_4 — 0.1-megohm potentiometer.
MA — 0–1 d.c. milliammeter.

To adjust the range initially, ground the receiver a.v.c. circuit and set R_4 for zero meter reading. Then remove the ground and tune in a strong signal. Note the point of maximum deflection, which should be at nearly full scale on the meter. If it is not, the value of R_3 and R_5 may be changed. Both resistors must be changed an equal amount to sustain balance in the bridge. *Increase* the resistance if the meter reads too high; *decrease* it if the reading is too low. A second method of adjustment is to insert a variable resistor between points X and Y. This may be a wire-wound resistor with a slider or a wire-wound potentiometer or rheostat. The first method eliminates the extra control, and thus is preferable.

A higher-range meter may be used, but the full-scale value should not exceed the maximum rated plate current drawn by the tube with zero grid bias.

— Kenneth M. Miller, W9NQT

SIMPLIFIED DESIGN OF LOW-FREQUENCY DISCRIMINATOR TRANSFORMERS

The action of FCC in permitting n.f.m. on some of the lower-frequency bands has stimulated interested amateurs to build limiter-discriminator units to be added to their 455-kc. receiver i.f. amplifiers. At present, 455-kc. discriminator transformers are not available on the market, and the design of such a transformer without a great deal of laboratory equipment is quite difficult. Most standard 455-kc. i.f. transformers are not adaptable. The coupling between the primary and secondary windings is quite critical for correct bandwidth, and can be adjusted only by sliding the coils up and down the form, a most difficult operation. It is possible, however, to couple the primary and secondary windings capacitively, which makes the bandwidth adjustment merely a small trimmer condenser.

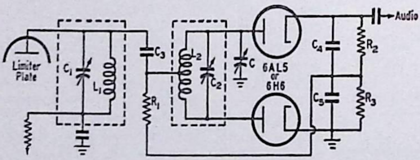


Fig. 2-8 — A method of overcoming the lack of low-frequency discriminator transformers. Two separate tuned circuits are coupled through a fixed capacitance. Bandwidth is then adjusted by means of a small mica trimmer, C.

C — 3-30 $\mu\mu$fd. trimmer.
C_1, C_2 — 100-$\mu\mu$fd. trimmer.
C_3 — 47-$\mu\mu$fd. mica.
C_4, C_5 — 100-$\mu\mu$fd. mica.
R_1, R_2, R_3 — 0.1 megohm, ½ watt.
L_1 — 1.5-mh. pie from 455-kc. i.f. transformer.
L_2 — Same as L_1, but center-tapped.

The circuit is shown in Fig. 2-8. Inductances L_1 and L_2 are pies from any replacement 455-kc. i.f. transformer. C, the bandwidth control, is a 3-30 $\mu\mu$fd. mica compression trimmer. The two coils have no magnetic coupling between them and are preferably mounted in separate shield cans. The unbalance provided by C causes current to flow in the secondary of the same phase which would be supplied by straight magnetic coupling. Thus, to change the bandwidth, merely adjust C, tune C_1 for maximum a.m. output, tune C_2 for minimum a.m. output, and the job is done. A few trials should give the desired bandwidth.

— Harry R. Hyder, W3NVL

CURE FOR UNTUNABLE SIGNALS

Are you hearing a miscellaneous jumble of untunable signals in the 28-Mc. band? If so, look to your antenna change-over relay and clean up its contacts. Oxidized silver is probably acting as a rectifier.

NO-KINK SCHEME FOR 'PHONE CORDS

Here is a kink destined to solve that ever-present problem of headphone leads getting in the op's way. Run an extension lead from the receiver up the wall and along the ceiling of the shack. Put a 'phone jack on the ceiling over the operator's position. By inverting the earpieces the cords go right up, completely out of the way.

— J. C. Nelson, W2FW

MOBILE RECEIVER FOR 75-METER 'PHONE

With 75-meter 'phone open to mobile operation, the question of a receiver can be solved easily by anyone who owns a BC-454 (3 to 5 Mc.) Command receiver, and who has a broadcast set installed in his car.

The BC-454 was found to be unsatisfactory when used alone, lacking both selectivity and audio output, but when its 1425-kc. i.f. circuits were used to introduce the hamband signals to the car receiver, in "Q5-er" fashion, both of these shortcomings were overcome. In fact, it is necessary to use only the first three tubes in the BC-454. This lowers the "B"-supply drain, and results in less "hash" than when the i.f. stages of the BC-454 are used.

A double-pole double-throw switch is used to switch the BC-454 receiver out of the circuit when it is desired to use the broadcast set for its original purpose.

— Marion D. Conham

DIODE NOISE LIMITER FOR CAR RECEIVERS

It is not necessary to have an extremely hot receiver for the mobile station, since noise is almost always the limiting factor, rather than receiver sensitivity. Even if you have your own car noise suppressed completely, the racket from other cars can give you plenty of trouble. A sim-

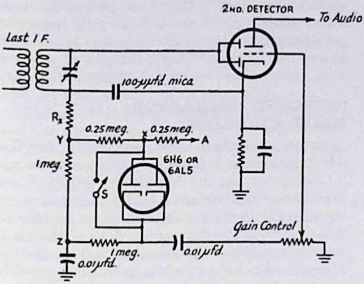


Fig. 2-9 — Schematic diagram of a simple diode noise limiter for use in a car radio receiver. If the a.v.c. voltage comes from the plate of the last i.f. tube, ignore the a.v.c. connection. If it comes from the second detector and does not use the same diode for both detection and a.v.c., change the circuit so it does. Try connecting the a.v.c. to points *X*, *Y*, and *Z*, in that order. Try connecting point *A* to cathode, or ground, whichever gives best results. Use a 6H6 as first choice, in preference to a 6AL5. Do not use a crystal diode. Resistor R_x appears only in some receivers and may be left in the circuit.

ple and effective noise limiter is shown in Fig. 2-9. It works only with diode tubes; don't try a crystal diode — it won't work. Use a 6H6 in preference to the 6AL5. Avoid the use of a limiter which requires a knob adjustment. The one shown is the automatic-level type, and it does a nice job.

— *R. V. Anderson, W3NL*

COUPLING 500-OHM 'PHONES TO THE RECEIVER

With tube-to-500-ohm-line transformers still scarce, many amateurs are faced with the problem of using 500-ohm 'phones with their receivers without burning out the output tube, its

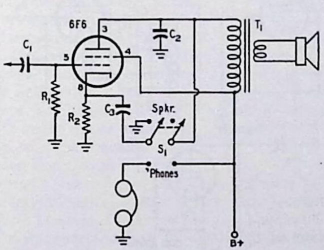


Fig. 2-10 — Proper operation of the output stage of the receiver when 500-ohm 'phones are used is provided by the connection of a d.p.d.t. switch, as shown. All other parts shown in the diagram are those usually found in the receiver.

C_1 — 0.01-μfd. 600-volt paper.
C_2 — 0.005-μfd. 600-volt paper.
C_3 — 10-μfd. 25-volt electrolytic.
R_1 — 0.47-megohm, ½ watt.
R_2 — 470 ohms, 2 watts.
S_1 — D.p.d.t. toggle switch.
T_1 — Tube-to-voice-coil transformer.

plate by-pass condenser, the output transformer, or all three, because of high peak voltages developed as a result of operating the tube with improper load on the voice-coil winding.

Operating the output tube as a cathode follower, as shown in Fig. 2-10, solves all of these problems with the additional advantage of producing excellent frequency response and very low distortion. By the addition of a double-pole double-throw toggle switch as shown, and a little rewiring of the components that are already in the receiver, proper operating conditions under both 'phone and 'speaker loads can be easily achieved.

— *Robert C. Potter, VE3TO*

A NOISE LIMITER USING GERMANIUM CRYSTALS

Many stations are bothered by ignition and other noises, often to the point of spoiling what would be a good QSO. As a result of the war, there has been developed a diode that has char-

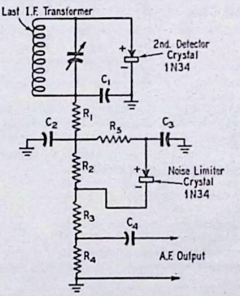


Fig. 2-11 — A second-detector-and-noise-limiter circuit utilizing germanium crystal rectifiers instead of tubes.

C_1, C_2 — 47-μμfd. mica.
C_3, C_4 — 0.1-μfd. paper.
R_1 — 47,000 ohms.
R_2 — 0.27 megohm.
R_3 — 0.1 megohm.
R_4 — 0.33 megohm.
R_5 — 1 megohm.

acteristics such that a remarkable noise limiter can be built into most communication receivers with a minimum of change. The diode is the 1N34 Sylvania germanium crystal which exhibits polarized nonlinear current-voltage characteristics. This diode starts to work with much less signal than the typical vacuum-tube diode and has less electrostatic capacity, making it more suitable for use in a high-frequency i.f. amplifier. The circuit shown in Fig. 2-11 is in use by the writer. A brief description follows.

In the schematic the diode load resistor is the series combination of R_1 through R_4. C_1 and C_2 in combination with R_1 make up the r.f. decoupling network.

Resistor R_2 is where the noise is dissipated. As can be seen, the 1N34 germanium diode is connected in shunt across the resistor after first being connected through a 0.1-second time-constant *RC* network. R_3 is an audio decoupling resistor before the audio output network, R_4 plus C_4.

This limiter is remarkably effective on noise or pulses of steep wave front and short duration such as are emitted by automobile and aircraft ignition systems.

— *Wm. F. Frankart, W9KPD*

AN "INTERCOM," "PHONO-AMP" AND RECEIVER COMBINATION

This combination intercommunication system, phono-amplifier and conventional receiver arrangement may prove handy in a ham shack or club room.

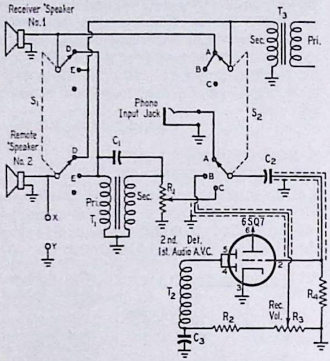


Fig. 2-12 — Combination radio, phono-amplifier, and intercommunication circuit using a standard receiver.

C_1, C_2 — 0.01 μfd.
C_3 — In receiver.
R_1 — 1-megohm "inter-com" gain control.
R_2 — In receiver.
R_3 — In receiver, volume control.
R_4 — 2 megohms.
S_1, S_2 — 2-gang single-pole 3-position switch.
T_1 — Microphone transformer.
T_2 — I.f. transformer secondary, in receiver.
T_3 — 'Speaker output transformer.

Fig. 2-12 shows the output circuit of my superheterodyne receiver and the modifications and additions necessary to permit this flexible operation.

With S_2 in position B, and S_1 in position E, the detector circuit of the receiver is connected to the triode section of the second detector and the receiver 'speaker is connected to the output transformer, T_3, in a normal manner.

With S_1 in position E and S_2 at C, the triode section of the 6SQ7 amplifies speech from 'speaker No. 2 (used as a microphone) through the microphone transformer, T_1. 'Speaker No. 1 is still connected to the output transformer, T_3, and receives the "output" of 'speaker No. 2. Push-to-talk operation, with control at the receiver end of the circuit, is possible by placing S_1 at D. Phono-amplification is obtained with S_2 at A.

With S_2 at either A or B, on either phono-amplifier or radio, 'speaker No. 1 may be used alone, if S_1 is at E. However, if S_1 is at D, both speakers are operated in parallel.

In the present installation, we have our remote 'speaker (No. 2) located in the movie-projection booth. By connecting the primary of a second microphone transformer to terminals X and Y, and the secondary to the phono-jack in the movie sound amplifier, we are able to pipe radio programs or music from records into the movie hall, or to use either 'speaker for announcement purposes.

— *Lyman H. Howe*

IMPROVED OSCILLATOR-MIXER COUPLING

Anyone who has been aggravated by that troublesome interaction between mixer and h.f.-oscillator circuits known as "pulling" will find the use of an untuned buffer stage interposed between the oscillator and the mixer an effective means of reducing the trouble. This method is an improvement over the usual pentagrid-converter arrangement, in that while the former provides good isolation, it does so at the expense of lowered sensitivity, because the conversion transconductance of the tube is comparatively low.

In order to achieve freedom from pulling, and at the same time maintain mixer sensitivity, an untuned triode may be used as a buffer, as shown in Fig. 2-13. This takes advantage of the fact that although the control grid has a large influence on the plate circuit of a tube, the influence of the plate on the control grid is negligible. We have, then, a one-way affair that does not allow the mixer tuning to "back up" into the oscillator.

The grid of the triode is coupled to the tuned circuit of the oscillator, and the plate of the triode is, in turn, coupled to the tuned circuit of the mixer, the connection being made by a tap on the tuning coil of the mixer only a turn or two above ground. This permits the use of a high-sensitivity tube such as the 6AC7/1852 or 6SK7 as a mixer.

It should be noted that poor interstage shield-

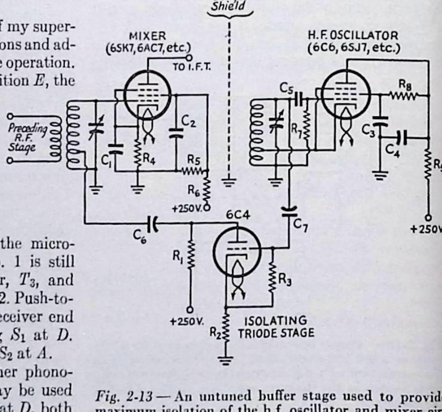


Fig. 2-13 — An untuned buffer stage used to provide maximum isolation of the h.f. oscillator and mixer circuits to reduce "pulling."

C_1, C_2, C_3, C_4 — 0.01-μfd. paper.
C_5 — 220-μμfd. mica.
C_6, C_7 — 0.005-μfd. paper.
R_1, R_6 — 0.1 megohm.
R_2 — 2200 ohms.
R_3 — 0.47 megohm.
R_4 — 22,000 ohms.
R_5, R_8, R_9 — 47,000 ohms.
R_7 — 10,000 ohms.

ing or injudicious placement of parts will tend to undo the benefits of the isolating triode. Conversely, any measure designed to prevent the oscillator and mixer from coupling by means other than through the triode buffer stage will make the arrangement more successful.

Choice of a 6C4 miniature triode is favored because the tube is small, its power drain almost negligible, and it seems to give results equal to those obtained with pentodes, in spite of expectations to the contrary.

The results have been something more than encouraging. Over all amateur frequencies up to 30 Mc., sharp tuning peaks in the mixer stage are regained without disturbing the oscillator frequency, and the receiver can be peaked for maximum sensitivity with decidedly less need for readjustment. In addition, the buffer presents a constant load to the oscillator, eliminating the trouble encountered in some receivers of oscillator failure in certain parts of the tuning range. No longer are dead spots encountered as the receiver is tuned through its range.

No doubt there is room for more experimentation on this subject, and it is hoped that others will be stimulated to make similar investigations along this line.

— *Clyde P. Brockett*

TELETYPE RECEPTION WITH MAKE-BREAK KEYING

Amateurs who are now using teletype machines for communications work may be interested in a system that was developed and tested by the writer in 1946 [and described in detail in June, 1949, *QST — Ed.*]. As at that early date there seemed to be no amateur interest in this form of communication, the work was dropped. This system uses off-on keying and gets around the necessity for using two-tone modulation or frequency-shift keying. It has a very substantial capability of discrimination against noise.

A loop circuit was set up between locations in downtown and midtown New York over a 5-mile path. The 11- and 2-meter bands were used. Both teletype machines were located downtown. Transmission north was accomplished with a surplus 144-Mc. crystal-controlled transceiver with one-watt output. The signal was received on a similar unit and retransmitted south by a 10-watt 11-meter transmitter. The signal was picked up on an SX-28 and fed into the receiving teletype machine.

This location was extremely noisy — the S-meter readings averaged around S7 on building noises of all types. Haywire antennas were employed so the signal never boosted the S-meter reading much beyond S9. Despite this severe handicap, the system worked very well. Amateur-teletype fans should obtain excellent results as they will rarely, if ever, encounter such poor receiving conditions.

The receiver circuit is shown in Fig. 2-14. A reverse-diode r.f. noise limiter is used in conjunction with a blocking-oscillator "tone-noise generator." The audio amplifier of the receiver can be followed by an audio filter, if desired, or the output can be fed directly into the rectifier. The rectified audio output of an SX-28 is sufficient to operate the teletype relay directly. The low-current teletype relay generally used in radioteletype work will reduce the audio output requirements.

The blocking oscillator shown in the diagram operates at the receiver's intermediate frequency. The repetition rate can be adjusted to any convenient frequency; between 400 and 600 cycles is a good choice. The output level of this oscillator is not important because the noise limiter clips the peaks. When the carrier is "on," the limiter operates and the locally-generated noise of the blocking oscillator is squelched. The carrier "on" condition thus becomes the teletype "space" position. The carrier "off" condition permits the blocking oscillator and any received noise to make the "mark" signal.

The system will operate successfully until the signal drops below the level of limiting or until local noise becomes so continuous that it keeps the receiver squelched all the time. The random nature of most received noise makes this an extremely unlikely occurrence.

— *Dana A. Griffin, W2AOE*

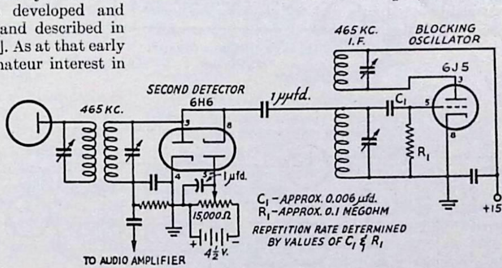


Fig. 2-14 — Circuit diagram of the second-detector circuit used with a standard communications receiver. The blocking oscillator provides noise pulses for the "mark" teletype signal.

MODIFYING THE HQ-129-X FOR N.F.M. RECEPTION

Comparing Figs. 2-15A and 2-15B will acquaint the reader with the circuit modifications made in a well-known communications receiver, the HQ-129-X, to convert it into an a.m.-n.f.m. receiver. It will be seen that a ratio detector is used. The output on n.f.m. will be somewhat less than on a.m. because R_1, which is a rather heavy load, is across the total output of the two diodes in the n.f.m. position. If desired, this resistor could be left in the circuit at all times, thus equalizing the a.m. and f.m. audio outputs. A crystal diode was substituted into the noise-limiter cir-

cuit so that the detector would be more or less balanced.

The only disadvantage in using this circuit lies in choosing a proper value for R_1. Although the value given works satisfactorily, the exact value should be determined experimentally, using a 100,000-ohm potentiometer in each receiver set-up for maximum results. The lower the value of resistor R_1, the better the performance from the standpoint of independence of amplitude variations. On the other hand, raising the value of R_1 increases the sensitivity. The optimum value of this resistor depends on the selectivity curve of the i.f. amplifier and the characteristics of the detector transformer, and hence must be determined experimentally in each installation.

Alignment of the ratio detector is similar to the alignment of a discriminator. However, in the absence of instruments the following procedure can be used: First, tune in an unmodulated carrier and adjust the transformer primary tuning for maximum output, as indicated on the S-meter. To adjust the secondary, tune in an *amplitude*-modulated signal and adjust the secondary tuning for *minimum* audio output. The

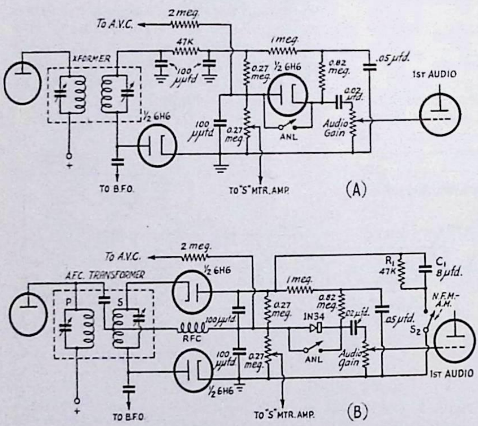


Fig. 2-15 — A — HQ-129-X second-detector circuit; B — circuit revisions necessary to provide alternative a.m.-f.m. reception.

a.m. carrier should be kept "on the nose" of the i.f. in this adjustment. A final check on a narrow-band f.m. signal will show whether or not the system is reasonably well balanced. When the detector is working properly the speech from a good n.f.m. signal will sound undistorted and the audio volume will not change when the manual r.f. gain control is varied over a considerable portion of its range.

Application of the ratio detector to other types of receivers will, of course, differ in detail depending upon the particular type of second-detector circuit employed. If the fundamental circuit is kept in mind, however, it should not be difficult to arrive at a modification that will work in whatever type of receiver you may happen to have.

— *L. H. Allen, W4IZH*

MODERNIZING THE PREWAR HRO

After extended use at W8GZ the writer believes that the following suggested conversion represents a worth-while improvement in any prewar HRO. What the author has done is to apply to the HRO the improved circuit of the HRO-7, with certain minor modifications dictated by simplicity.

Conversion of the H.F. Oscillator

Conversion of the high-frequency oscillator consists of substituting a 6C4 and associated 0A2 regulator tube in place of the 6C6 or equivalent oscillator and the adding of a temperature-compensating condenser across the oscillator bandspread trimmer condenser. Circuit details are given in Fig. 2-16.

Remove the present h.f. oscillator tube and socket from the chassis. With a hack-saw blade or similar tool enlarge the present tube-socket hole into a rectangular hole approximately 1¼ by 2 inches. Cut a piece of sheet aluminum into a rectangle approximately 2⅜ inches by 2⅝ inches. On this piece of aluminum mount the sockets for the 6C4 and 0A2 tubes. Space these sockets approximately 1¼ inches between centers. This socket assembly is now centered over the rectangular hole in the chassis and fastened in place by means of small bolts or rivets in each corner of the aluminum sheet. The 6C4 tube must be located toward the front. Connect the 6C4 and 0A2 as shown in the wiring diagram of Fig. 2-16.

Temperature Compensation

Temperature compensation is obtained by connecting a 10-μμfd. ceramic condenser, with a coefficient of − 0.00077 μμfd./μμfd./°C, across the oscillator bandspread trimmer condenser. This temperature compensation is used on the 28-, 14- and 7-Mc. coils. It cannot be used on the 3.5-Mc. coils without modifying the coil-assembly components, which is hardly worth while.

Remove the h.f. oscillator brush board (the bar with four contact fingers in the right-hand coil slot) and add a fifth contact arm to this brush board, by using a piece of spring brass or

any other similar material. The brush board is already drilled and slotted for the fifth contact. All that is necessary is to fashion the arm out of suitable metal and fasten it on the board with a small bolt or rivet. If you desire, a new 5-contact brush board can be purchased very cheaply directly from the National Company, Malden, Mass.

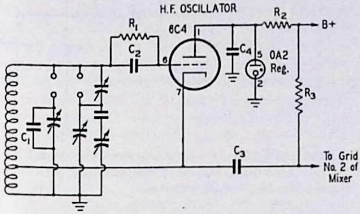


Fig. 2-16 — Revisions in the high-frequency oscillator circuit.

C_1 — 10-$\mu\mu$fd. ceramic, -0.00077 $\mu\mu$fd./$\mu\mu$fd./°C (see text).
C_2 — 100-$\mu\mu$fd. ceramic.
C_3 — 0.01-μfd. mica, 600 volts.
C_4 — 0.1-μfd. 400-volt paper.
R_1 — 22,000 ohms, ½ watt.
R_2 — 5000 ohms, 10 watts.
R_3 — 0.1 megohm, ½ watt.

Connect the temperature-compensating condenser from this new contact arm to ground. Be sure to leave the condenser leads long enough so that the compensating condenser can be pressed against the 6C4 oscillator tube. Use a small ceramic stand-off insulator to support this condenser and give it mechanical rigidity.

Next remove the 28-Mc. h.f. oscillator coil can from the plug-in rack and remove the coil assembly from its shield can. Solder a connection from Contact 1 (it is plainly marked and was previously unused) to the stator connection of the bandspread trimmer condenser. Make it short and stiff for mechanical rigidity. Replace into the shield can and back onto the rack. Repeat the operation for the 14- and 7-Mc. coils. Leave the 3.5-Mc. coils untouched.

Warm up the receiver and realign the bandspread trimmer on the h.f. oscillator coils for 28, 14 and 7 Mc. This is Adjustment 7 in the HRO instruction manual. A slight decrease in capacity is necessary, because you have added 10 $\mu\mu$fd. across this trimmer. Remember that the h.f. oscillator should always be on the high-frequency side of the signal, so if your oscillator tunes at two points the counterclockwise one is the correct point. See page 8, HRO instruction manual. Check your bandspread. On the 28-Mc. coil, 28.0 Mc. should come at 50 on the dial and 29.7 Mc. should come at 450 on the dial. Similarly, the band limits for the 14- and 7-Mc. coils should come at 50 and 450. If the bandspread is out, realign as outlined on pages 8 and 9 of the manual.

Exact temperature compensation is secured by pressing the compensating condenser closer to or farther away from the 6C4 oscillator tube. In the writer's receiver the correct point is approximately ⅛ inch from the center of the side of the 6C4 tube. At W8GZ this adjustment gives a maximum drift at 29.7 Mc. of plus or minus one (1) dial division, starting with an absolutely cold receiver.

If the oscillator "sqegs," or operates at several frequencies simultaneously, reduce the grid leak to around 18,000 ohms or else use a grid condenser of lower capacity. Do *not* change the oscillator coil!

A final point on temperature compensation. Remember that a cold coil plugged into a hot receiver will have some drift in spite of your compensation. You can correct this by keeping the extra coils on top of the receiver or any other place where their temperature will be substantially the same as that of the receiver. If you desire, you can introduce additional temperature compensation directly into the plug-in coils by removing the coils from their shield cans and soldering a small negative-coefficient condenser from Terminal 1 to Terminal 4 on the 28-, 14- and 7-Mc. coils. The exact size of this condenser will depend upon your own particular HRO. After adding the condenser you must still be able to "zero" the oscillator with the bandspread trimmer condenser. The writer's experience has been that condensers of from 3 to 5 $\mu\mu$fd., with a coefficient of -0.00077/$\mu\mu$fd./$\mu\mu$fd./°C, are about the maximum usable capacities. A little trial and error will give you the best possible combination. However, unless you do a lot of coil shifting this coil compensation is hardly necessary.

Noise Limiter

At W8GZ one of the rhombic antennas parallels a state highway for nearly 1000 feet. The ignition interference is terrific! After much cut-and-try, the writer settled upon the circuit shown in Fig. 2-17 as giving the best results with a minimum of change in the HRO.

The first step is to take your HRO "as is" (either with or without the h.f. oscillator conversion). Connect a signal generator or some source of definitely fixed and unvarying signal to the antenna terminals and feed a 28- or 14-Mc. signal into the receiver. The exact frequency is unimportant. Tune in this signal very carefully and make a note of the S-meter reading. You are now ready to begin work.

Remove the 6B7 second detector and its socket from the chassis and replace with a 6H6 socket and tube. Connect it as shown in Fig. 2-17. Mount the 6H6 noise limiter and 6SJ7 first audio into the chassis directly behind the S-meter, the 6H6 noise limiter to the front. The noise-limiter control is mounted to the lower right of the headphone jack. Connect as in Fig. 2-17. Both 6H6 tubes use 4.3-ohm 2-watt resistors in series with the heaters to reduce the voltage at the sockets to 5.0 volts.

The noise-limiter control may be either a 0.5-megohm potentiometer with a tap at 20,000 to

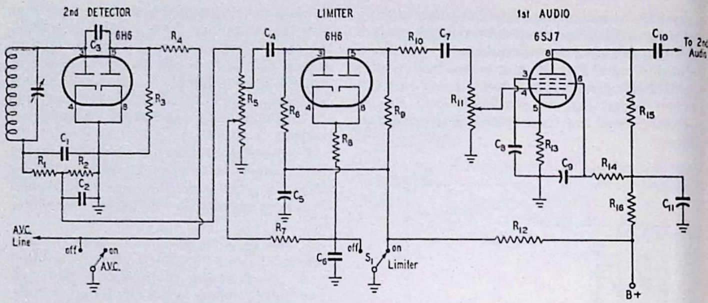


Fig. 2-17 — The revised second detector and first audio, and the new limiter, are from the circuit of the HRO-7.

C_1 — 270-$\mu\mu$fd. mica or ceramic.
C_2, C_3 — 100-$\mu\mu$fd. mica or ceramic.
C_4, C_5, C_6, C_9, C_{10}, C_{11} — 0.1-μfd. 400-volt paper.
C_7 — 0.01-μfd. 600-volt paper.
C_8 — 25-μfd. 50-volt electrolytic.
R_1, R_{16} — 47,000 ohms.
R_2, R_9 — 0.47 megohm.
R_3, R_4 — 1.5 megohms.
R_5 — 0.5-megohm potentiometer tapped at 22,000 ohms (IRC Type D17-133X) or as in Fig. 2-18.
R_6, R_7, R_8, R_{10} — 0.22 megohm.
R_{11} — 0.5-megohm volume control.
R_{12}, R_{14} — 0.82 megohm.
R_{13} — 2200 ohms.
R_{15} — 0.1 megohm.
All resistors half-watt.
S_1 — Switch mounted on R_5 (IRC No. 43).

25,000 ohms (Fig. 2-17) as is used at W8GZ, or it may consist of a 0.5-megohm potentiometer shunting a 22,000-ohm and a 0.47-megohm resistor (Fig. 2-18) as in the HRO-7.

After completing the wiring realign the 6H6 second detector for maximum output. (Refer to Adjustment 13 and 14, HRO instruction manual.)

Reconnect the signal generator or signal source and again tune the signal in carefully as before.

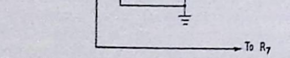


Fig. 2-18 — A substitute circuit for R_5 of Fig. 2-17.

The S-meter reading will now be somewhat lower than it was before adding the noise limiter. Using a long screwdriver or similar tool *very carefully* increase the capacity of the crystal-filter output coupling condenser by turning clockwise (Adjustment 9, HRO instruction manual) until the S-meter reads the same as before installing the limiter. Do *not* go beyond this point or you will lose selectivity.

Your conversion is now complete. The S-meter should operate exactly as it did before conversion. You have a receiver with an extremely stable oscillator and an excellent noise limiter — and last but not least the over-all gain of your receiver is slightly higher than it was before you started work. While you are at it hadn't you better check your tubes and then touch up the alignment of the entire receiver in accordance with the procedure outlined in the instruction manual?

— *Loren G. Windom, W8GZ*

[Editor's Note: Owners of early-model HROs are referred to another conversion article on this receiver, "'Souping Up' a War-Surplus HRO," by Paul D. Rockwell, W3AFM, in February, 1949, *QST*.]

SELECTIVITY . . . AND MORE SELECTIVITY

Apparently you have to hear the W9AEH receiver ("A Super-Selective C.W. Receiver," August, 1948, *QST*) before you really wake up to this selectivity business. Harold Leighton, W9LM, writes to tell what he did after listening to the receiver on several occasions. He was so impressed that he wanted something like it. He had a McLaughlin Selectable-Sideband Adapter (April, 1948, *QST*) on the tail end of his HQ-129, but it wasn't good enough on c.w., so he added a little additional selectivity. He took six Hammarlund SS-50 transformers (special low-frequency transformers available for the McLaughlin system) and increased the separation between pots by ⅜ inches, to loosen the coupling. He then built an i.f. amplifier using two of these transformers between each stage, and patterned the detector circuit after the McLaughlin design. For a 50-kc. b.f.o. he used the coil from a BC-453 surplus unit, padded with micas and tuned by a 100-$\mu\mu$fd. variable.

To give him the various degrees of selectivity he wants, a 4-position switch is used. The first gives straight audio output from the HQ-129, with the crystal filter in Position 4. In the second

position, the headphone output is taken from the selectable-sideband adapter. Position No. 3 gives the receiver selectivity plus the selectable-sideband adapter selectivity plus the six loose-coupled SS-50s selectivity, and No. 4 uses all this plus an audio filter! A beat note of about 375 cycles is generally used, and in Positions 3 and 4, no signal has ever been heard on the other side of zero beat, and practically all signals are gone by the time the beat reaches 800 cycles on the high side. Plates have been removed from the band-spread condenser in the 129, and only 150 kc. is covered on 14 and 28 Mc., and on 3.5 and 7 Mc. only 30 kc.! The main bandset condenser is reset to cover the band. On 40 and 80 meters, all of the selectivity can be used practically all of the time. The most trouble with drift comes from the HQ-129 b.f.o., which is used only in Position 1 and so is of little importance. Fine tuning is available on the 50-kc. b.f.o., however, and a handy gimmick is the pair of pencil marks on the panel that permits flipping the b.f.o. from one spot to another that gives exactly the same beat note on the other side of the signal.

SOURCES OF "SHARP" LOW-FREQUENCY I.F. TRANSFORMERS

Amateurs interested in the construction of their own Q5-er strips will be interested in the following letters bearing on the surplus sources of hard-to-find low-frequency i.f. transformers:

From George Goldstone, W8MGQ: "The CFI unit from an ART-13 transmitter has some coils that might be used in sharp low-frequency transformers. The little unit marked 'Z-2201' (there are two in a CFI) contains a 50- and a 200-kc. tuned circuit. Both inductors are slug-tuned in powdered-iron pots, and they are mounted side by side in a bakelite housing inside a shield can. By removing the 200-kc. coil and substituting the 50-kc. coil from another unit, it should be possible to make a fair transformer. On the *Q*-meter, the 50-kc. coil shows a *Q* of 80 at 85 kc., just twice that of the coils in the 85-kc. transformers used in the BC-453. Some stores have the Z-2201 units for 25 cents — a CFI unit for about $1.50 has two Z-2201 units."

From A. E. Pugh, VE5AP: "The Bendix MN-26 radio-compass receiver, available in surplus, contains a total of 22 powdered-iron pots and cores, with various coils mounted in the pots. Many of them tune to around 110 kc., so they are in the range and might be useful. The receiver has a wealth of condensers and resistors, a 5-gang tuning condenser and a 24-volt dynamotor."

ELIMINATING TIRE STATIC

Mobile enthusiasts who have had their reception disturbed by a noise similar to leaky power-line interference will do well to look to their cars' tires. This form of interference is caused by friction between the inner tube and tire casing, and can be remedied by introducing one of the new "tire powders" — such as Chevrolet part No. 986035 — into the tubes.

— *Harold G. Price*

A "HOT" FRONT END FOR THE RME-69

After having heard the performances of some of the new receivers, the author was rather discouraged with the one in his ham shack. Regardless of the fact that ten years ago it performed along with others in the same general price bracket, it just didn't have the "sock" of the newer ones. Furthermore, images on ten and twenty meters were sometimes bothersome. Consequently, the "old friend," which had done its job in an excellent fashion all these years, had fallen into disrepute. A new receiver was out of the question, so it was decided to find out just what might be done in the way of improving the performance of the old. It might be well to mention here that the receiver concerned is an RME-69, but it is felt that the improvements to be described are not peculiar to this particular receiver and may be duplicated in others. The original r.f. amplifier circuit is shown in Fig. 2-19.

In looking over the field, no major improvements in circuits could be found on newer receivers outside of such things as noise suppressors, etc. Fundamentally, the new receivers remain superheterodynes and the improvements in sensitivity and selectivity have been brought about mainly by the use of better components and tubes.

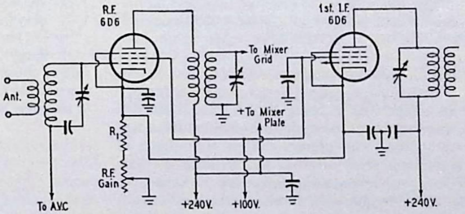


Fig. 2-19 — Circuit of the original r.f. amplifier in the author's RME-69 receiver. The band-change switch and meter circuit are not shown. R_1 is 150 ohms.

In surveying the newer tubes, it became apparent that the 6AK5 was by all means the tube to use in the r.f. amplifier of a receiver. Its input admittance is fairly low at 28 Mc. and, in addition, its transconductance is in the order of 5100 compared to around 1500 for tubes such as the 6K7, 6D6, etc. What could be simpler? An adapter was made from an old 6-prong tube base and a 6AK5 was substituted for the 6D6 in the r.f. stage of the RME-69. The results were far from startling; in fact, the only improvement noticeable was at frequencies lower than about 10 Mc.

In view of the fact that the 6AK5 and 6D6 are not designed to operate at the same values of

bias, screen and plate voltages, the failure of the experiment was attributed to this. The receiver was taken out of the cabinet and by the use of several resistors and associated by-pass condensers, voltages were adjusted to those rated for the new tube. The other components in the r.f. amplifier stage were left as found. An immediate improvement in gain was measured on all frequencies, varying from 18 db. at 2 Mc. to 4 db. at 30 Mc., with several frequencies showing gains in the order of 25 db. The resulting increase in gain was so startling to the author, and the receiver had so much "sock," that it was left in this condition for several weeks, and once again it seemed like a new receiver rested on the operating desk.

However, being a true ham, and considering that in spite of the improved gain at the lower frequencies there had been relatively little increase in gain and image rejection on ten meters, it was decided to carry the investigation further.

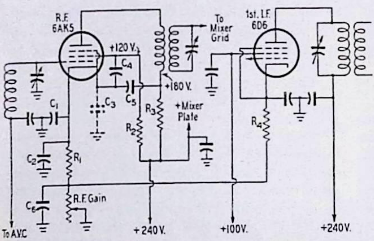


Fig. 2-20 — Modified r.f. circuit for the 6AK5 r.f. amplifier.

C_1, C_2, C_4, C_5, C_6 — 0.1-μfd. paper.
C_3 — 470-$\mu\mu$fd. mica.
R_1 — 220 ohms.
R_2 — 47,000 ohms.
R_3 — 6800 ohms.
R_4 — 330 ohms.

In attempting to bring up the gain at 30 Mc., it was considered possible that degeneration was entering into the picture — that the length of the cathode lead external to the tube, in particular, was introducing inductive reactance at the higher frequencies, thereby reducing the gain at 30 Mc. Accordingly, it was decided to discontinue use of the adapter and install the miniature socket in place of the old 6D6 socket, thus shortening the leads considerably. Furthermore, upon studying the receiver, it was found that grid, screen, and plate by-passes were brought to the chassis rather than to the cathode terminal of the socket. The control-grid ground return could not be connected to this terminal because the tuning-condenser rotor was grounded. Since lifting the condenser from ground would have involved a major construction job, it was left as originally installed. All other by-passes were returned to the 6AK5 cathode terminals. This tube has two such terminals, one for grid returns and the other for plate returns. The decision to alter these by-pass connections ultimately made the r.f. stage work.

Immediate improvement in gain at 30 Mc. was noted, amounting to some 12 db. over that obtained before work on the receiver was started. Simultaneously the signal-to-image ratio was increased to better than 30 db. Since this is considerably greater than would be expected from the tuned circuits even if there were no loading, it seems evident that regeneration contributes to this sort of performance; in fact, the stage had a tendency to oscillate at certain spots within the two higher-frequency ranges. This instability was eliminated completely by the use of C_3 as shown in Fig. 2-20.

A comparison of the original of Fig. 2-19 and the modified circuit of Fig. 2-20 will show the change in the original by-passing. Some of the condensers were originally located several inches away from the r.f. tube socket and were common to either the mixer or the first-i.f. amplifier tubes. The two 0.1-μfd. cathode by-pass condensers shown are actually there. One goes from the cathode to the ground terminal in the middle of the socket and the other goes from the cathode to the ground terminal of the a.v.c. circuit by-pass at the ground end of the r.f. tank coil.

— *William L. North, W7BIE*

MOUNTING METERS IN CRAMPED QUARTERS

When there is not room to mount an S-meter on a panel because of lack of room behind the panel, as is often the case with war-surplus receivers, the idea shown in Fig. 2-21 may solve the problem. Remove the meter from the case, and grind down the entire flange of the case, as shown. This may be done with a grinding wheel, smoothing the corner with a file. After grinding the flange away, sandpaper the rest of the outside of the case to give it a finish that will match the crackle finish of the panel. Wash out the inside of the case with soap and water, and reassemble.

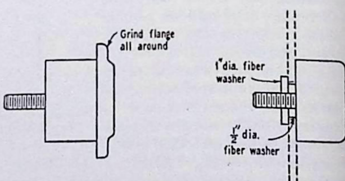


Fig. 2-21 — Method of mounting meters on the outside of a receiver panel.

The meter is then mounted on the panel by drilling two ½-inch diameter holes and using fiber washers to insulate the meter terminals from the panel. It will be necessary to remove all of the nuts from the terminal bolts to bring the back of the meter flat against the front of the panel. No damage will result if care is taken not to drive the bolts back into the case. The finished result makes a very neat-looking job.

— *Gordon V. N. Wiley, W1AUN*

3. Hints and Kinks . . .

for the Transmitter

CURING UNBALANCE IN PUSH-PULL AMPLIFIERS

In many instances it seems difficult to obtain exact balance in both tubes of a push-pull r.f. amplifier. One tube will show color while the other runs cool. A simple rearrangement of the wiring of the filament circuits will sometimes effect the desired balance when nothing else seems to do the job. The arrangement used at W2MFS and W2HFS to correct unbalance in push-pull 810 stages is shown in Fig. 3-1.

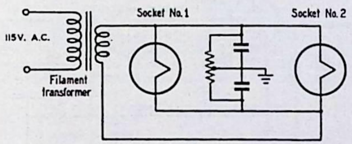


Fig. 3-1 — **A filament-wiring "kink" to correct unbalance in push-pull amplifiers.**

An *exact*-center-tap-and-by-pass arrangement is used, with the by-pass condensers located midway between the two sockets. A center-tapped resistor is used rather than the usual center-tapped filament transformer. In addition, the filament leads are wired from opposite ends, as shown. In this manner any possible voltage drop in the wires themselves is equalized so that both tubes will operate at identical filament voltage.

— *Herb Spohn, W2GMM*

INDUCTIVE NEUTRALIZATION OF THE 813

After many hours of trying in vain to neutralize a pair 813s by conventional methods and never knowing whether I had too much or too little capacity, I finally decided to try inductive neutralization. A one-turn link was wound around the center of the grid coil with "bell" wire and brought over to the center of the plate coil with 70-ohm Twin-Lead where another one-turn link was constructed. With grid drive on and plate power off, the final grid and plate tanks were tuned to resonance. A 60-ma. bulb coupled to the plate tank almost burned out. The swinging link neutralizer was then slowly pushed into the center of the plate tank, and the bulb grew brighter so the 70-ohm Twin-Lead connections to the link were reversed and presto! the bulb grew dimmer. The swinging link was pushed in a little at a time until the 60-ma. bulb went out completely even though it was tightly coupled to the plate tank. The whole operation from start to finish took only a few minutes. With 700 watts input and 100% modulation, the 813s were really stable for the first time.

Homemade swinging links for the neutralizing leads were constructed and installed in the 10-meter final and also in the 20- and the 75-meter finals. All three have been working for over a year and much more satisfactorily than any other method yet tried here.

— *Philip Rand, W1DBM*

BALANCING PUSH-PULL DRIVE

It is well worth while reminding those who build push-pull amplifiers of the importance of balancing the drive to the two tubes. This becomes even more important when using tubes like 807s, since underdriving of one tube can combine with the harmful effects of overdriving the other to give some pretty discouraging performance. In the capacitance-coupled push-pull amplifier with which we were working, provision for balance, as shown at C_1 in Fig. 3-2, was included. The output capacitance of the driver tube was looked up in the tube data and the balancing condenser, C_1, was set to what was estimated roughly by eye to be an equivalent capacitance. The amplifier performed very poorly. The output was considerably below the rated value and the dip in plate current at resonance was negligible when the amplifier was loaded to rated input. Finally, it was noticed that one plate was showing some coloring. A check of the individual screen currents (a convenient indication of balance in a push-pull amplifier, since the tank circuits don't have to be opened up for the meter) showed that one tube was drawing almost no

screen current, while the screen current of the other was considerably in excess of its rating. It was found that a very careful adjustment was necessary to bring the two screen currents to the same value. The difference in performance after accurate balancing was remarkable. Good efficiency was obtained and off-resonance plate current increased to between 350 and 400 ma., giving a very pronounced dip to the rated 200

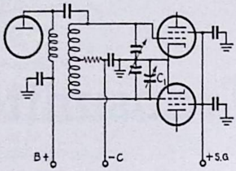


Fig. 3-2 — The excitation to push-pull tubes can be balanced by use of a balancing condenser, C_1, in the input circuit. Its value should be the same as the output capacitance of the driver tube.

ma. at full rated load — and this with the screens supplied from a dropping resistor. Apparently, before balancing, one tube had been doing almost all of the work. With one tube loaded up to nearly 200 ma. it isn't surprising that the plate-current dip was negligible!

Let us repeat, too, another reminder. Hold the grid current of 807s and other beam tubes to the rated value at the recommended operating bias. Overdriving spoils the performance of tetrodes by running the screen current up unnecessarily. With a series resistor, this drives the screen voltage down, making it difficult to load the amplifier properly.

— *Don Mix, W1TS*

PROTECTING SCREEN-GRID TUBES

A simple method of protecting the large screen-grid tube against failure has been described in the past for the case where the screen current is supplied to the tube through a series dropping resistor from the plate supply ("A Medium-Power Bandswitching Transmitter," Smith, *QST*, October, 1946). A different and more serious problem is introduced when the screen current is supplied from a low-voltage source of comparatively good regulation, such as the exciter power supply. In this instance, loss of plate or bias voltage is almost always fatal to the amplifier tube if the full screen potential is still applied.

The circuit shown in Fig. 3-3 offers a simple method for protecting the tube against failure of the plate supply, and at the same time eliminates the need for fixed bias. First consider the circuit with the amplifier tube V_3 operating under normal conditions. The negative grid bias developed across R_1 is applied to the grid of V_1, thereby cutting off its plate current, so for the moment this tube may be disregarded. R_3 and R_4 act as a voltage divider across the plate supply of the amplifier tube. Their values are such that the voltage at their junction point is approximately equal to the desired operating voltage for the screen of the amplifier tube.

If a sufficiently-high voltage is applied to the plate of V_2, it will conduct, and the potential applied to the plate of V_2 (less tube drop) will appear at its cathode, serving as the screen voltage of V_3. This in turn is controlled by the grid voltage of V_2, which is determined by R_3R_4. If, however, the plate voltage of V_3 is removed, the grid of V_2 falls to ground potential, approximately, tending to reduce sharply the conductivity of V_2, thus reducing the screen potential on the amplifier tube. Thus V_2 serves to protect the tube against failure of the plate supply while excitation and screen voltage are applied.

The function of V_1 is to protect the amplifier tube against failure of excitation while plate and screen voltages are still applied. If the excitation is removed from the grid of the amplifier tube, V_3, the grid of V_1 returns to zero, and plate current is drawn through R_4. This reduces the voltage on the grid of V_2, causing its conductivity to be decreased, thus lowering the screen voltage on the amplifier tube to a point where plate and screen dissipation are not excessive.

For a practical case, assume that the desired amplifier screen voltage is of the order of 300 to 400 volts. A 6J5 tube may be used for V_1, and a

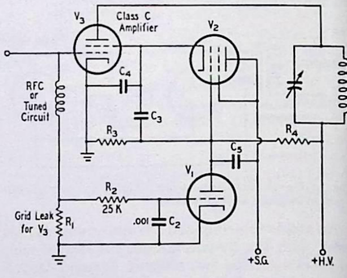


Fig. 3-3 — Protective circuit for screen-grid tubes when a separate screen supply is used. The "protective-tube" idea is applied through a series tube to reduce screen voltage automatically whenever excitation or plate voltage is removed.

6L6G, with the screen and plate tied together, may be used for V_2. If the screen current in the amplifier tube is about 30 or 40 ma., the drop across V_2 will be 75 to 100 volts. Thus the screen supply will have to furnish this extra voltage. R_3 and R_4 should be about 500 ohms per volt. Since the current through them is small, they may be made up of a number of 2-watt carbon resistors in series, the value of each resistor being 0.25 megohm or less. A separate filament transformer is required for V_2. If the screen current supplied to V_3 is modulated, C_3 and C_5 must be large enough to pass the modulation frequencies.

— *W. B. Bernard, W1QUR*

W2ASB HAS A REAL SEND-RECEIVE SWITCH

Tom Garretson, W2ASB, changed the s.p.s.t. toggle switch in his receiver to a d.p.d.t. and connected the new elements of the switch in series with an outlet from which he obtained the 115-volt supply for his transmitter. Now when he throws the switch from *receive* to *send* — he does!

AUTOMATIC HIGH-LOW RANGE METER SWITCHING

It is often desirable to cut an amplifier's plate power input to a fraction of its original value. Such may be the case with a 1-kw. rig operating in a local net, in which it is desired to run less than 100 watts. The plate meter, usually 1000 ma. in such a rig, is difficult to read below 100 ma. One could more easily tune to resonance, with no load on the amplifier, using a 100-ma. scale, were it not for the danger of damaging the meter by accidental overloads.

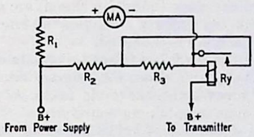


Fig. 3-4 — Automatic meter switching to read high or low currents. *Ry* operates when 200 to 250 ma. is drawn through its winding, thus shorting out R_3 and changing the full-scale reading from 100 to 1000 ma. when the resistances are used as shown below. The relay winding must pass 1000 ma. maximum current.
MA — 1-ma. meter.
R_1 — 1000 ohms, minus the meter resistance.
R_2 — 1 ohm, 2 watts.
R_3 — 3 ohms, 5 watts.
Ry — D.c. relay, designed to operate at 200–250 ma.

An automatic meter switch can be provided by the addition of a relay and a pair of resistors to the usual 1-ma. meter circuit. The relay, one of the type that operates when 200 or 250 ma. flows through its winding, automatically shifts the meter shunt from high to low as the current increases. The circuit is shown in Fig. 3-4.

This type of switching does not rely on the human element, and will provide protection for the meter and greatest ease in adjustment of the circuit. Through the use of different values of resistors, other current ratings may be obtained.

— *Kenneth M. Miller*

MAKING THE MOST OF 'PHONE JACKS IN THE SMALL RIG

Fig. 3-5 shows a method for using two closed-circuit 'phone jacks to provide an inexpensive keying and metering system for a small two-stage transmitter. With the circuit wired as shown the following may be accomplished: A meter may be inserted to read oscillator cathode current, amplifier current, or the total of both. Either the amplifier alone, or the entire transmitter, may be keyed.

To read oscillator current, plug the key into J_2 and the meter in J_1. To read amplifier current, plug the meter in J_2. To key both stages simultaneously, plug the key in J_1.

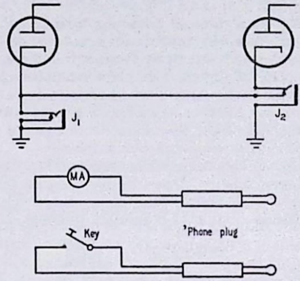


Fig. 3-5 — Simple arrangement of 'phone jacks to provide a flexible keying and metering set-up for a small transmitter.
J_1, J_2 — Closed-circuit jack.
MA — Plate milliammeter of suitable range.

An open-circuited 'phone plug may be used to turn off the oscillator during periods of reception when the amplifier alone is being keyed. The dummy plug is pushed into J_1 to kill the oscillator.

— *Harold Held, W9OCK*

SAFETY FIRST WHEN USING 'PHONE JACKS

Oftentimes a 'phone jack is wired in the cathode circuit of an r.f. amplifier to allow external metering of the stage. One side of the jack is placed at ground potential; therefore it is thought that all is safe — a most dangerous assumption. If the amateur uses a portable test meter everything is OK so long as the external circuit is kept closed. However, most test meters have small pin jacks for different ranges. If the amateur decided to change the range, what happens? He opens the external circuit and in so doing has carelessly placed the full plate voltage of the amplifier in his hands.

Moral — Shunt the jack with a 50-ohm resistor. This will not upset the meter reading yet it will protect the operator. Of course, this arrangement prevents keying of the stage. But who would be so foolish as to key directly the cathode circuit of a high-power amplifier?

— *Martha M. McVay, W7KCU*

SIX OSCILLATOR INPUT CIRCUITS ON ONE SOCKET

This circuit permits the first tube in a transmitter (such as a 6F6 or 807) to be used with equal convenience as an oscillator or as a buffer-amplifier. The circuit shown in Fig. 3-6 has been built into several transmitters during the past three years and has provéd entirely satisfactory.

The cathode bias resistor and condenser are sometimes at a moderate r.f. voltage above

ground, therefore they should be insulated accordingly. The value of cathode resistance is just sufficient to limit the plate current (zero signal) to a safe value. Since the cathode resistance used will vary with the type of oscillator tube and other circuit conditions, no value for R has been specified.

The plugs are old six-prong tube bases. The Tri-tet coil was wound on a homemade fiber bobbin, which was cemented in a tube base. The components for the grid-plate oscillator circuit were made to go into a tube base by using a very small size mica condenser and a single-pie r.f. choke. All of the tube bases were covered with thin bakelite discs cemented in place.

Although a coaxial-cable connector is provided, the tube may be driven by plugging an exciter output cable directly into the crystal socket, and providing a plug with suitable jumpers. If the

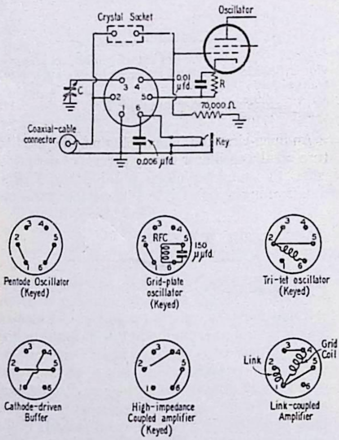


Fig. 3-6 — Six different oscillator-circuit arrangements are available in this versatile oscillator socket layout. Variable condenser C must be large enough (100 to 250 $\mu\mu$fd.) to resonate the Tri-tet coil or the link-coupled amplifier grid coil. The value of R will vary with various tubes and should be the normal cathode resistor for the tube selected.

coaxial-cable connector can be insulated from ground, it might be better to return the outer-shield connection to Pin 6 (the key jack) rather than to ground. This would permit using the tube as a cathode-keyed buffer or doubler.

— *Henry L. Cox, jr.*

DEVICE FOR BREAKING ARCS IN TRANSMITTERS

Fig. 3-7 shows the circuit of a device used to stop instantaneously any arc-over that occurs in the final-amplifier tank circuit of a 'phone transmitter. The coil of a relay that will "throw" when passing slightly more current than that drawn by the final amplifier under normal operating condi-

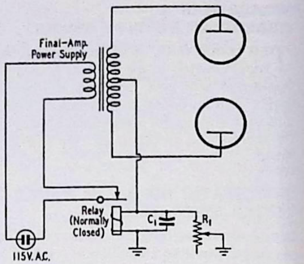


Fig. 3-7 — A fast-operating circuit that takes the rig off the air and puts it back on again in no time flat when an arc-over starts.
C_1 — 8-μfd. 150-volt electrolytic.
R_1 — 25-ohm wire-wound variable resistor.
R_y — 6-volt d.c. relay, s.p.s.t., normally-closed contacts (Guardian 200 series).

tions is inserted between the center-tap of the high-voltage transformer and ground. The contacts of the relay (normally closed) are arranged to break the primary circuit of the transformer when the relay is energized.

Once the relay has tripped, it resets itself automatically and closes the primary circuit. The entire break-and-make cycle takes only an instant, thus maintaining continuity of the transmitted signal except for an instant so brief that the receiving station often will not even know that an arc-over has taken place. Should there be a permanent short-circuit, the relay will oscillate with a buzzing sound that will be a sure tip-off to the operator to pull switches before the power transformer burns out.

The condenser shown in the diagram will absorb brief surges that do not result in an arc, and the variable resistor R_1 is used to set the point at which the relay will operate. A setting that causes it to operate at any overload 50 ma. in excess of the normal current drain will be satisfactory in most cases.

— *Eldon L. Kanago, WØUHC*

UNIFREQUENCY TRANSMISSION AND RECEPTION

This system was in use at prewar W5CAT and should appeal particularly to the many 'phone boys who have a receiver containing a crystal filter which is seldom used. The crystal is removed from the receiver and, as shown in the block diagram of Fig. 3-8, built into the exciter stages of the transmitter. A conventional mixer stage follows and produces a carrier frequency of exactly the frequency to which the receiver is tuned, the necessary heterodyning frequency being obtained by a simple pick-up loop coupled to the local oscillator in the receiver. The resultant frequency is continuously variable, following the receiver automatically up and down the band.

The advantages are obvious; when calling CQ, the operator simply searches for a clear channel

on the receiver and when the transmitter is turned on it occupies that channel. Sometimes when making a radical shift in frequency it is necessary to touch up the transmitter amplifier stages but that is to be expected in any VFO system. In answering a CQ the transmitter automatically comes squarely on the calling station's channel and the chances of making a contact are enhanced, especially if the calling station is also using this system.

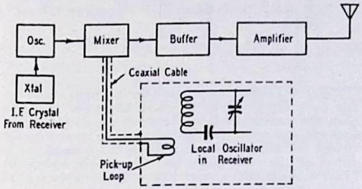


Fig. 3-8 — **W5CAT utilizes the i.f. crystal from his receiver in a transmitter frequency-controlling oscillator.**

It is conceivable that interference might be greatly reduced in all bands if this system was used widely, since stations in contact with each other would necessarily be using the same channel.

— *Cecil R. Gray, W5CAT*

HOMEBUILT MULTIPLE CRYSTAL HOLDER

An easy-to-build gadget that will permit a crystal-switching system to be installed in almost any existing transmitter is shown in Fig. 3-9. Construction details are self-evident from the drawing. The plug-in base is obtained from a National type PB-10 base-and-shield-can assembly. The top, on which six ceramic crystal holders are mounted, is a sheet of transparent insulating material. (Plexiglas, lucite or polystyrene will do.) It is held in position by four threaded brass rods, which are bolted to the 5-prong plug-in base as shown. The selector switch is mounted on another piece of similar material. This piece has grooved ends which slide in between the brass rods. The grooving is done with a small rat-tail file, and eliminates the need for drilling through the sheet edgewise.

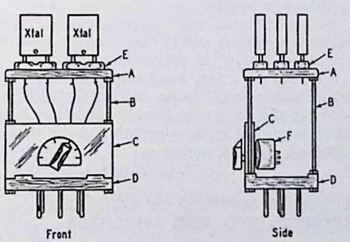


Fig. 3-9 — **Constructional details of a simple multiple crystal holder. The unit makes use of a 5-prong plug-in-coil base, and will hold up to six of the small-size crystal holders. *A, C* — sheet of ¼-inch transparent insulating material; *B* — 9/32 threaded brass welding rod; *D* — 5-prong coil base (National PB-10); *E* — ceramic crystal socket; *F* — six-position selector switch.**

The ceramic crystal sockets used are of the model that accommodates the new Type FT-243 crystal holders. Six of these fit into the upper "deck" without crowding. If desired, one of the sockets could be of the type that takes the old-style holder. By extending the brass rods, another deck may be added to permit use of twelve crystals. In this case, however, the shield can that comes with the unit cannot be used.

— *Bill Roper, W7DPK*

THREE-WAY CRYSTAL SOCKET

In many ways adapters for fitting the new small-size crystal holders into standard UY 5-prong sockets are not the ultimate solution to the problem of how to use three styles of crystal holders in the same rig without using three sockets. The homemade socket shown in Fig. 3-10 handles all three of the currently-popular holders without requiring adapters, and does it without any forcing, pinching, or binding. Its construction is simple, and the parts required can usually be found in the junk box.

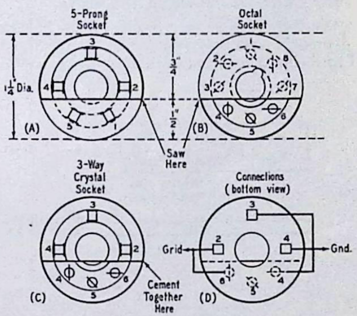


Fig. 3-10 — **Method of constructing a 3-way crystal socket from portions of a 5-prong socket and an octal socket. The two are cut as shown in A and B, and are cemented together as shown in C. The socket connections to permit use of any of the three popular sizes of crystal holders are shown in D.**

In this gadget, a portion of a 5-prong socket and a matching portion of an octal socket are cemented together to form a composite affair. The resulting pin spacings and contact diameters permit the use of the prewar "standard" crystal holders (0.125-inch diameter pins spaced ¾ inch), the FT-243 holder (0.089-inch pins spaced ½ inch), and the CR-1A/AR holder (0.125-inch pins spaced ½ inch). The old-type holder plugs into Pins 2 and 4 of the 5-prong socket, the FT-243 goes into Pins 4 and 6 of the octal portion, and the CR-1A/AR into Pins 2 and 3 of the 5-prong portion.

To make the socket, remove the locking ring

and mounting plate from the sockets. Needless to say, the sockets should both be of the same diameter and general type. Amphenol types S-5 and S-8 fill this requirement nicely. Saw the two as shown in the sketch, being careful to keep the cut square. If you want to be extra cautious about it, leave a little extra portion on each one and finish it smooth with a file. This will assure a good fit, and will permit the surfaces to be squared up in the event that the hack-saw cut wasn't quite true. Cement the portions together as shown in the sketch, and reassemble them in the mounting plate. If the two "halves" match well, the locking ring will hold them securely in place, and the socket can then be mounted in the chassis as any other socket would be. If you are extra careful to get a perfect fit, the mounting plate may be eliminated and the assembly can be mounted in a 1$^{11}/_{64}$-inch hole with the locking ring alone.

Ceramic sockets cannot be used in this gadget because they are impossible to saw. If, however, low-loss mica-filled bakelite sockets are used, the losses should be low enough to make the unit entirely satisfactory. It makes about the only satisfactory three-way crystal socket seen here to date.

— *Basil C. Barbee, W5FPJ*

TWO CRYSTAL-HOLDER SOCKETS

The increased use of FT-243 crystal holders brought forth these two sockets. In Fig. 3-11A I used clips taken from a Millen crystal socket to

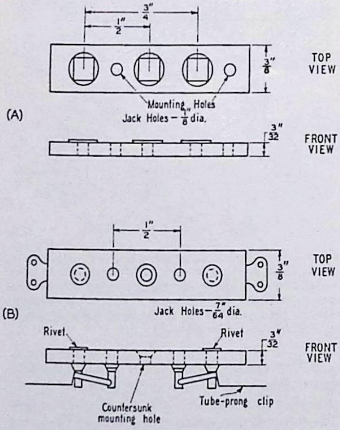


Fig. 3-11 — Two crystal-holder sockets fabricated by W1LIG. In A, clips from a Millen crystal socket are spaced for both amateur standard and FT-243 holders. Another style, for FT-243 holders only, is shown in B and utilizes clips from a tube socket riveted in place.

make up a socket that will accept both amateur standard and FT-243 holders. Fig. 3-11B takes only the FT-243 holder and is made from two tube-prong clips riveted in place.

— *Dr. J. E. Greenbaum, W1LIG*

ELIMINATING STAND-BY DRIFT IN A VFO

Some of the drift in a VFO can be avoided by permitting the oscillator tube to run continuously. However, in spot-frequency operation, even the weak signal from the oscillator is not desired and must be removed. Cutting the plate

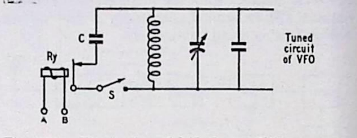


Fig. 3-12 — Elimination of drift during VFO stand-by. The relay (operated by a source of power available when the transmitter is on) removes the padding condenser *C* from across the VFO which then returns to the desired operating frequency. When the transmitter is turned off the relay closes and the padder lowers the VFO frequency sufficiently to move it out of the way of the incoming signal in the receiver.

This method of moving the VFO frequency is *not recommended* for keying the oscillator, as the contact capacity of the relay will make signal chirp or "yoop."

voltage allows the tube to cool and when turned on again, the output may be on a different frequency. The scheme shown in Fig. 3-12 eliminates this drift. After the oscillator has reached normal operating temperature its frequency may be shifted off the band by closing *S*, thus placing the condenser *C* across the tuned circuit. This capacity should be enough to move the oscillator frequency out of the band being worked. When the transmitter is on, the relay opens this padder circuit and the oscillator returns to the desired transmitting frequency. When the transmitter is switched off, the relay operates and connects the padder back into the circuit and the operating frequency is clear for reception. This scheme keeps the oscillator plate current constant.

The circuit may be modified to cut some portion of the oscillator tank capacitance in and out, in which case the relay would normally be open and would close the circuit on transmit, thus placing the stand-by signal higher than the operating frequency.

Such a device will not work as a method of keying as the opening and closing of relay contacts will make "yoops" in the oscillator signal.

A suitable d.c. relay can be connected in series with the cathode of a buffer or amplifier tube. An a.c. relay should be connected in parallel with the antenna relay or across some other circuit that is energized when transmitting.

— *J. W. Brannin, W6OVK*

A SIMPLE METHOD OF COUPLING BETWEEN VFO AND AMPLIFIER

I have found that the output of my VFO (a Signal Shifter) is sufficient to drive an 807 buffer or doubler without employing a tuned circuit in the grid of the 807 stage, although the ECO unit is on the operating table several feet from the transmitter. The method of connection

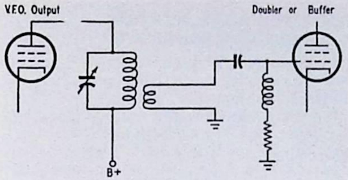


Fig. 3-13 — Remote-coupling method for VFO or exciter.

shown in Fig. 3-13 is, admittedly, an inefficient way to transfer power; but maximum efficiency is unimportant, so long as the stage receives sufficient drive. The ease with which this 807 is driven indicates that a higher-powered stage, employing an 813 or similar tube, could be operated by the same method.

— *John P. Isaacs, W6PZV*

VARIABLE END-LINKED COILS

When high-power tetrodes are used in a single-ended amplifier circuit, it seems wasteful to use a split-stator tank system to obtain a variable link. Since no variable end-link coils were available, one was made in the following manner:

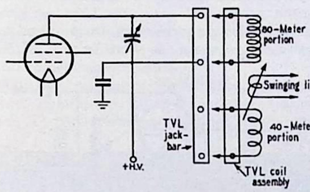


Fig. 3-14 — Method of obtaining variable-link coupling with single-ended circuits. Two bands are covered with a single coil assembly, as described in the text.

A standard B & W 500-watt TVL jack bar was used to hold the plug-in coils. The associated split-center TVL coils were altered by removing one of the two identical windings on the 80-meter coil, and substituting in its place one of the windings from the 40TVL coil. The result is a coil that can be used on 80 meters when it is plugged in one way, or on 40 meters when it is plugged in after 180° rotation. A 20–10 meter coil was made in like manner from the 20- and 10-meter TVL coils.

Fig. 3-14 shows the circuit connections necessary to permit this arrangement. The inoperative portion of the coil assembly has no effect on the performance of the amplifier, as it is not connected to the circuit in any way, and is isolated from the operative portion by the swinging link. [In rare instances, the "floating" coil might be self-resonant at the operating frequency, resulting in a wavetrap action, but if this is the case, it can be detuned with a condenser or shorted to ground to eliminate the trouble. — *Ed.*]

This arrangement is not applicable to single-ended triode stages where a balanced circuit is needed for neutralization.

— *Walter Zuckerman, W2LBF*

COUPLING NETWORK FOR WORKING SEVERAL BANDS ON ONE ANTENNA

For several years at W2LIW I used a pi-section network, sometimes called a "Collins coupler," because of the ease with which it enabled me to work over a wide range of frequencies in several bands with one antenna. The antenna was a 66-foot end-fed Hertz, with a number of bends.

The transmitter was located in the attic, about 35 feet above the ground. When operated at 3.5 Mc. it was being fed near a current loop, with large currents flowing to ground. As the 35 feet of steam pipe, electrical conduit, etc., which comprised the lead to actual ground, represented a considerable fraction of a wavelength, the transmitter in the attic was quite a few volts above ground. As a result the r.f. got into a number of places where it had no business — in the lighting system, for example. Since the power supply delivered only 30 watts to begin with, I resented a

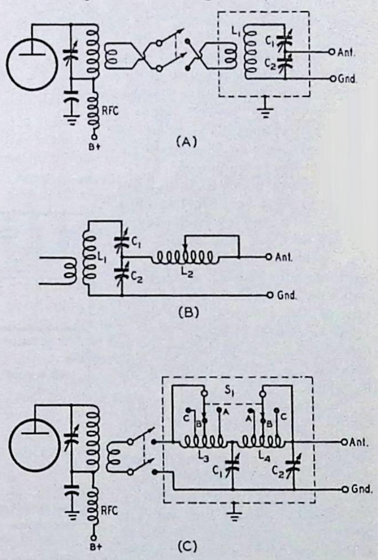


Fig. 3-15 — (A) Wide-range antenna coupling network. (B) Loading coil used with above coupler for working a very short antenna on a very low frequency. (C) Tapped antenna coupler for a bandswitching transmitter.
C_1 — 250-$\mu\mu$fd. variable, widely spaced.
C_2 — 500-$\mu\mu$fd. variable, widely spaced.
L_1 — To resonate at desired band with low capacity.
L_2 — 30 turns, 2½ inches diameter.
L_3 — 30 turns, 2½ inches diameter, tapped.
L_4 — 40 turns, 3 inches diameter, tapped.
S_1 — Double-pole 4-position tap switch.

large portion of this being wasted in illuminating bulbs in various parts of the house, particularly since the orange glow produced was useless for practical purposes.

After a good bit of experimentation the system shown in Fig. 3-15A was evolved. The important thing is to see to it that the coupler itself is completely insulated from the transmitter ground (chassis) and link-coupled to the transmitter. Then the ground lead from the coupler is carried to an actual ground (in my case the water main in the cellar) and carefully insulated all along its length. No. 14 wire supported on stand-offs is suitable. Absolutely nothing else is to be connected to this ground lead. Links on both the final tank and the antenna coupler may be permanently coupled closely, as all variations in loading are taken care of by C_2, the 500-$\mu\mu$fd. variable output condenser. The other condenser, C_1, is a 250-$\mu\mu$fd. variable.

The coupler tank coil, L_1, is cut so that it will resonate in the desired band with very low tuning capacity. The entire unit is placed in a shield can which is grounded to the transmitter chassis, while the coupler is carefully insulated from the shield.

The tuning process is the same as with any other form of pi network. The transmitter first should be tuned up with the d.p.s.t. switch in the link open. After that the transmitter is not touched. Loading is adjusted by means of C_2, a surprisingly easy process. Resonance is achieved by varying C_1. Then the power is going to the right place, as can be observed easily by placing an r.f. meter in the antenna lead.

A variation which is useful when working, say, a very short antenna system on a very low frequency, is by the addition of a loading coil, L_2, as shown in Fig. 3-15B. If mechanically feasible, this loading coil might be placed at the open end of the antenna. This would move the current loop, the point of maximum radiation, farther out in the clear, a definite improvement in design.

The arrangement shown in Fig. 3-15C is excellent for a band-switching transmitter. The two switch sections comprising S_1 may be ganged after the optimum position for the taps has been found by experiment. What has already been said concerning insulation still applies, and the tuning process is the same.

At W2LIW, one coupler was used from 1.8 to 14 Mc. For 28 Mc. a v.h.f. version was constructed, using two 50-$\mu\mu$fd. midget condensers and an air-wound coil. All leads were made very short. Excellent results were obtained.

— *Harry R. Hyder, W8NVL*

THE TEN-DOLLAR WONDER — A TRANSFORMERLESS VFO

IT WAS GREAT to be back on the air again, but with the choice of only a few prewar crystals I often felt the lack of a VFO.

But where was I going to scare up half-a-hundred bucks for a commercially-built unit? QRM grew worse so the time came to analyze the contents of the junk box. It revealed some midget variable condensers, tube bases — and best of all, a 70L7GT and a 6G6G. Some old aluminum-base 16-inch transcriptions supplied stock for the chassis. (All there is to cleaning them is to dip them in very hot water and then peel off the acetate coating with a knife, starting at the edge.)

It was thought that by using a transformerless power supply, fair regulation might be obtained without the use of voltage regulators. This proved true in spite of line voltage changes from 95 to 115. This arrangement also simplified the power-supply problem from the standpoint of economy, stability and size. The whole unit, shown in the photographs, measures 6 by 6 by 3 inches.

The 75-ohm resistor, R_5, and the 150-ma. bulb were added to protect the rectifier section of the 70L7GT because high current is encountered in charging the filter. Capacitor C_{10} is required to reduce hum and should not be omitted. (See Fig. 3-16.)

No screen-dropping resistors are required and no cathode bias resistor is used for the 70L7GT

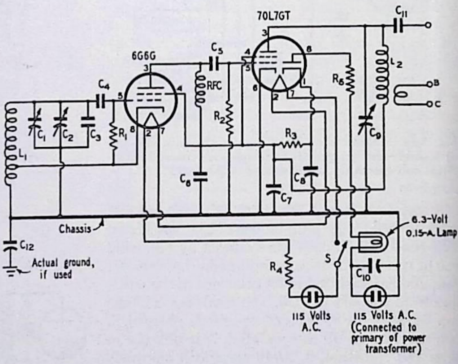


Fig. 3-16 — Schematic diagram of the low-cost transformerless VFO. The heavy line denotes the chassis. The unit is actually grounded only through the protective condenser, C_{12}. High-impedance output is taken from C_{11}. A low-impedance link may be connected to *B* and *C*.

C_1 — 50-$\mu\mu$fd. variable.
C_2 — 140-$\mu\mu$fd. variable.
C_3 — 600-$\mu\mu$fd. mica.
C_4, C_5, C_{11} — 100-$\mu\mu$fd. mica.
C_6 — 0.01-μfd. mica.
C_7 — 40-μfd. electrolytic.
C_8 — 20-μfd. electrolytic.
C_9 — 100-$\mu\mu$fd. variable.
C_{10}, C_{12} — 0.05-μfd. paper.
R_1 — 47,000 ohms, ½ watt.
R_2 — 100,000-ohm ½-watt 70L7GT grid leak.
R_3 — 1000-ohm 10-watt B + filter resistor.
R_4 — 250-ohm line-cord resistor.
R_5 — 75 ohms, ½ watt.
L_1 — 19 turns, tapped at 4 turns. (1.8 Mc.)
L_2 — 25 turns. Link — 2 turns (3.5 Mc.). Both L_1 and L_2 are wound on the tube bases with No. 20 wire.
S — S.p.s.t. "on-off" switch.

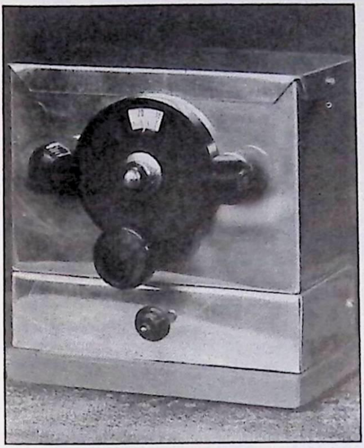


Fig. 3-17 — Front view of the ten-dollar VFO.

because it gets sufficient bias from the grid leak. The two coils are mounted at the back of the chassis so that there is no chance for them to be warmed by the tubes. The oscillator coil is unshielded. The unit sits on a wooden desk and no metal comes near the back of it.

With the condenser combination as shown it is just possible to cover the entire 160-meter band. The 6G6G is an excellent oscillator and

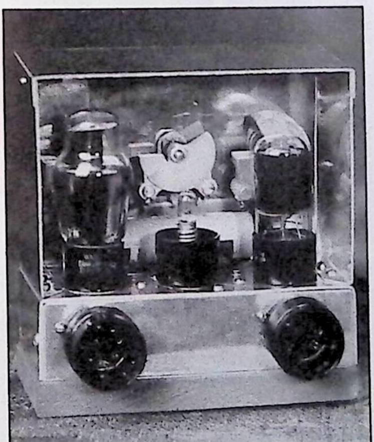


Fig. 3-18 — Rear view of the VFO shows its compact arrangement. The coils are mounted on the rear of the chassis which must be kept clear of other units on the operating desk when in use.

runs cool. The 70L7GT doubles to 80 meters with over a watt output, sufficient to take the place of a crystal. I connected it to the grid of the regular 6L6 oscillator through C_{11} without even a ground return, and with an unshielded three-foot lead at that. The 6L6 stage then quadruples to "20" as if it were a Tri-tet.

We thought this design too good to keep to ourselves, after news of this compact and stable VFO was received with unusual enthusiasm by others to whom we described its features. The cost of this unit was in the neighborhood of ten dollars. I like that neighborhood.

— *Don Langbell*

SOME NOTES ON THE CLAPP OSCILLATOR

THE following notes on the Clapp series-tuned oscillator (see "A High-Stability Oscillator Circuit," May, 1948, *QST*) are a result of the author's experience in building a VFO using this circuit. It is hoped that they will be useful to others.

The circuit used is shown in Fig. 3-19. Values are conventional, but only high-quality components were used.

Greatly-improved isolation between the oscillator and succeeding buffers may be accomplished with the circuit as shown. One half of a double triode (12AU7 or 6SN7) is used as the oscillator and the other section operates as a cathode follower. The low output impedance of the cathode follower makes the voltage and frequency less sensitive to load changes. W2FBA has used a cathode follower to isolate other VFOs, but the Clapp oscillator lends itself very simply to this circuit. If the oscillator is not keyed, the follower grid may be directly coupled to the oscillator cathode, since little or no d.c. voltage exists at this point. If the oscillator is keyed in the cathode circuit, capacity coupling should be used to prevent the open-circuit cathode voltage from appearing on the follower grid.

It was found that an r.f. choke in the cathode circuit of the follower improved the output. The output is somewhat less than that from the oscillator alone, although neither is very large. In this installation about 3 volts output was obtained, enough to drive a 6AC7 Class A. The 6AC7 was found to be superior to the 6AG7 in cases where the grid drive is small. This is to be expected from the high perveance of the 6AC7. In addition, it was desired to keep power dissipation to a minimum, and the 6AC7 gives more output at lower current. A 2E26 may be driven to full output with the 6AC7 operating Class A from the cathode follower.

The mechanical construction used with this type of oscillator must be considerably more rugged than with the usual high-*C* VFO. The junction between the tuning capacitor and the coil is very hot and any change in stray capacitance at this point will spoil the stability. The coil and condenser should be firmly mounted so that no relative motion can occur between these

components or between them and the shield.

Available ceramic coil forms did not give *Q*s which came up to expectations. An air-wound coil similar to the B&W type, having a length about equal to its diameter, was selected as having the best *Q*. The coil was clamped on one side

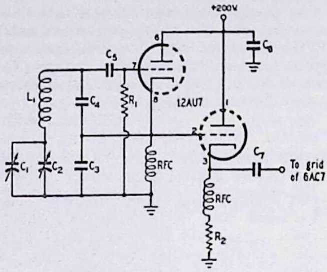


Fig. 3-19 — Series-tuned oscillator with cathode follower stage.
C_1 — 50-μμfd. variable.
C_2 — 15-μμfd. variable.
C_3, C_4 — 0.001-μfd. silver mica.
C_5, C_7 — 100-μμfd. mica.
C_6 — 0.01-μfd. mica.
R_1 — 0.1 megohm, ½ watt.
R_2 — 15,000 ohms, ½ watt.
L_1 — 45 turns No. 18, 2¼-inch diam., 2¼ inches long. (See text.)
RFC — 2.5-mh. choke.

in a polystyrene bracket. The *Q* of this coil without a shield was measured as 275 at 3.5 Mc. It should be realized that placing a shield around a coil will reduce its *Q*. The coil should be spaced from all sides of the shield by a distance at least equal to the coil diameter to lessen the reduction in *Q* by the shield.

The usual precautions as to condenser bearings should be observed. The small amount of tuning capacitance used in this circuit makes the frequency more dependent upon strays and minimum capacitance of the condenser. Condensers in which spacing can be changed with longitudinal pressure on the shaft should be avoided.

The keying properties of the circuit were investigated only as a matter of academic interest. A barely-discernible chirp seems to be present with the usual filter arrangements. Previous experience with the critical tastes of the FCC in the matter of key clicks made it desirable to eliminate them from this unit. In any keyed oscillator the frequency will change as the applied voltage builds up; the Clapp oscillator is no exception, although it is considerably better than others. If the rise in the keyed voltage is sharp the chirp will appear as a click, and many cases of clicks may be traced to this effect. Wishing to have none of these difficulties, it was decided to allow the oscillator to run continuously and to take advantage of the mechanical construction to accomplish the necessary shielding. This proved to be a practical solution; no trace of the oscillator can be heard on anything but the fundamental (3.5 Mc.) and this is not objectionable. The unit is keyed in the Class A 6AC7 following the oscillator.

No measurements have been taken on the stability of the VFO. After a warm-up period of 15 to 20 minutes the oscillator will stay in zero beat with a 100-kc. crystal for long periods of time. The main source of drift seems to be the expansion of the inductance. This could be compensated for by negative temperature-coefficient capacitance.

The Clapp oscillator is most certainly superior to previously-used types. It is not a cure-all for VFO troubles, though, and considerable care must be used in construction to realize its capabilities.

— *Richard G. Talpey, W2PUD*

TUBULAR CONDENSER FOR ANTI-TVI APPLICATIONS

Fig. 3-20 gives in cross-section the details of a tubular capacitor for effectively by-passing v.h.f. r.f. currents between the plate and cathode of an amplifier tube, thereby eliminating v.h.f. parasitics which contribute to TVI. The condenser is especially adapted for tubes

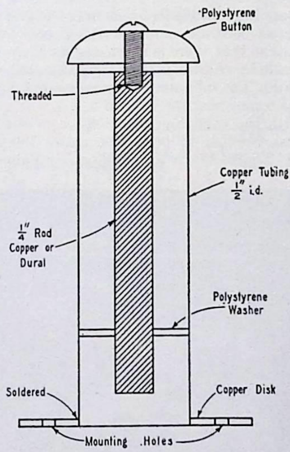


Fig. 3-20 — Homemade tubular condenser for providing short r.f. path between plate and cathode, for tubes having the plate connection at the top. A condenser 4 inches long has a capacitance in the vicinity of 10 μμfd.

having the plate connection at the top, because it can be mounted vertically alongside the tube.

As shown in the sketch, the unit is mounted over a hole in the chassis near the grounded connection of the amplifier-tube cathode, for shortest r.f. path; the plate is connected to the screw at the top. Homemade condensers of this type have relatively low capacity — 10 to 15 μμfd. — depending on the length and spacing of the tubing sections.

4. Hints and Kinks . . .

for the 'Phone Rig

MINIMIZING HUM IN SPEECH AMPLIFIERS

An extremely simple yet effective way to minimize hum is apparently overlooked by or unknown to most amateurs. If you have an audio unit plagued by 60-cycle hum, place approximately 10 volts positive bias on the heater or filament circuit. This can be accomplished in the following typical manner:

Across the 300-volt d.c. plate supply place a 0.3-megohm ½-watt resistor in series with a 10,000-ohm ½-watt resistor as shown in Fig. 4-1.

Where the resistors join, the potential is 10 volts positive. Connect this point to either side of the filament circuit after making certain that neither side of this circuit nor the center tap of the filament transformer is grounded. Larger resistors than ½-watt are not needed because the current drain through the bleeder is slight.

If it is desirable to tap across a d.c. source of different voltage than that used in the example

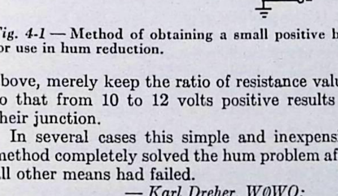


Fig. 4-1 — Method of obtaining a small positive bias for use in hum reduction.

above, merely keep the ratio of resistance values so that from 10 to 12 volts positive results at their junction.

In several cases this simple and inexpensive method completely solved the hum problem after all other means had failed.

— *Karl Dreher, WØWO; Charles Murray, WØNWU*

INEXPENSIVE RELAY FOR PUSH-TO-TALK CIRCUITS

A useful adaptation of an automobile part to ham radio is the use of a double headlight relay in a push-to-talk system. I bought my relay from one of the automotive chain stores for $1.19 and it works swell!

— *M. E. Dahl*

DIRECT-COUPLED AUDIO AMPLIFIER

Fig. 4-2 shows a direct-coupled audio amplifier that I found simple to construct. It has a flat response from 30 to about 800 cycles with about

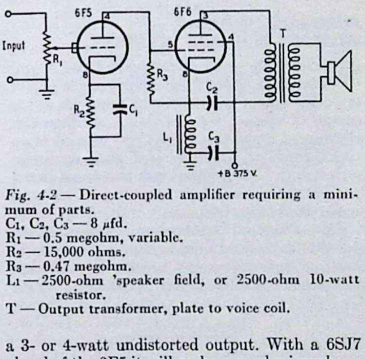


Fig. 4-2 — Direct-coupled amplifier requiring a minimum of parts.
C_1, C_2, C_3 — 8 μfd.
R_1 — 0.5 megohm, variable.
R_2 — 15,000 ohms.
R_3 — 0.47 megohm.
L_1 — 2500-ohm 'speaker field, or 2500-ohm 10-watt resistor.
T — Output transformer, plate to voice coil.

a 3- or 4-watt undistorted output. With a 6SJ7 ahead of the 6F5 it will make a good microphone amplifier, with a performance exceeding that of many other low-power jobs I have seen.

— *H. B. Ford*

BALANCING PHASE-INVERTER CIRCUITS

The arrangement shown in Fig. 4-3 provides a most convenient means of balancing phase-inverter circuits. It requires little equipment, and is perhaps more accurate than other more involved methods.

The primary of a plate transformer is temporarily connected in the B+ lead to the center tap of the output transformer. Headphones are connected across the secondary as shown. Signal input is then applied to the phase inverter, and the balancing potentiometer is adjusted until minimum signal, mostly distortion products, is

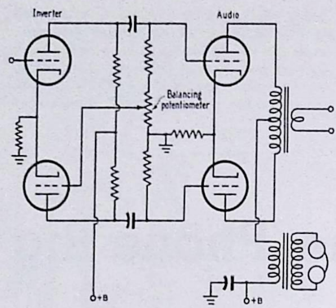


Fig. 4-3 — Arrangement used for balancing phase-inverter circuits without the use of elaborate test equipment.

heard in the 'phones. This point is very critical, and indicates balance of the inverter circuit. Slight variations introduced when replacing tubes can be offset by readjustment using the same method.

— *H. G. Brower, W2FQP*

PUSH-PULL CLASS-A WITHOUT A PHASE INVERTER

Shown in Fig. 4-4 is a push-pull Class A amplifier that some of the fellows might like to try. This circuit was borrowed from the sweep circuit of one of the Du Mont oscilloscopes. However, I found that it may also be used as an audio amplifier. I constructed such an audio system with 6L6s in the output and found that I had no trouble at all in obtaining 15 watts of undistorted power output.

The beauty of this hook-up appears in the fact that there is no need to use a phase inverter stage or push-pull input transformer. Because the cathode resistor is not by-passed, a slight amount of inverse feed-back is induced which tends to cancel out the small amount of distortion, if any.

In order to picture the mode of operation more clearly, follow through one cycle of the input excitation voltage. Beginning with the positive swing of excitation, as the voltage on the grid of V_1 goes positive it causes the plate current in V_1 to increase. The increase of current flowing through R_2 (the cathode resistor) causes the voltage drop across R_2 to increase with the grounded side of R_2 becoming increasingly negative. (This change is instantaneous since R_2 is un-bypassed.) This voltage also exists between the cathode of V_2 and its grid since the two cathodes are connected together and the grid of V_2 is grounded. Therefore the over-all effect on V_2 is the same as though a negative voltage was being applied on its grid from an external source. The remainder of the cycle may be traced out and in all cases as the grid voltage on V_1 varies the effective grid (bias) voltage on V_2 will vary 180 degrees out of phase with it. This gives true push-pull operation which cannot become unbalanced unless Class A operation is exceeded and V_1 allowed to draw grid current.

— *George H. Taylor, W7ITL*

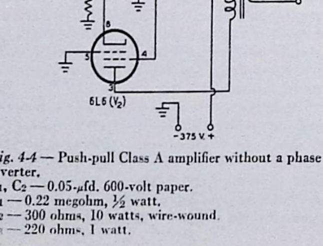


Fig. 4-4 — Push-pull Class A amplifier without a phase inverter.
C_1, C_2 — 0.05-μfd. 600-volt paper.
R_1 — 0.22 megohm, ½ watt.
R_2 — 300 ohms, 10 watts, wire-wound.
R_3 — 220 ohms, 1 watt.

INEXPENSIVE BCI CURE

Having about 75 midget a.c.-d.c. "cracker-box" sets in the immediate vicinity of my 250-watt 10- and 20-meter 'phone rig, I had to do something about the resulting BCI. It had to be inexpensive, yet effective. I found that by-passing one side of the heater of the combination detector/first-audio tube (usually a 12SQ7 or its equivalent) with a 0.001-μfd. mica condenser cured about 95 per cent of all cases when the trouble was caused by power-line pick-up.

— *Ted Wilds, W4GVD*

LOCK-ON FOR THE T-17B HAND MICROPHONE

I have noticed on several occasions when in contact with a station using a T-17B microphone that the audio is frequently interrupted. This is caused by the fact that it takes a lot of pressure to hold the switch button closed, and after a few moments the hand gets cramped. A simple solution to the problem requires only that a ¾-inch piece of No. 18 wire be soldered under the edge of the metal mounting washer that is found beneath the bakelite switch button. After reassembling, it will be possible to lock the switch in the "on" position with a slight twist of the button.

— *R. A. Cohagen, W8NBM*

BUILT-IN OSCILLOSCOPE FOR MODULATION MONITORING

The availability of 3-inch cathode-ray tubes (3AP1, 3BP1, etc.) and 8016 high-voltage rectifier tubes on the surplus market makes it possible for every amateur who operates 'phone to equip his transmitter with a built-in 'scope for modulation monitoring.

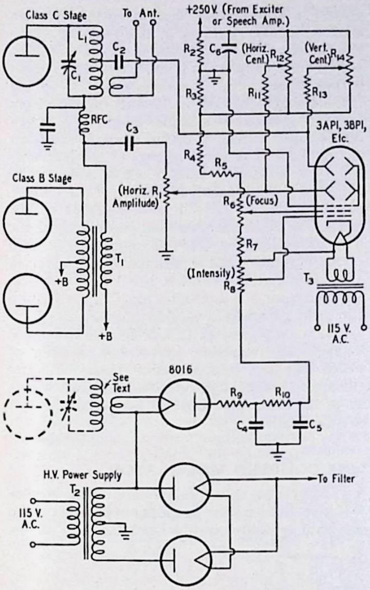


Fig. 4-5 — Circuit diagram of a built-in 'scope that costs little, utilizes the transmitter power supply, and can be added to any medium- or high-power 'phone transmitter.

C_1 — Final-amplifier tuning condenser.
C_2 — 50-μμfd. 5000-volt mica.
C_3 — 0.01-μfd. high-voltage mica or paper (oil-filled).
C_4, C_5 — 0.05-μfd. 1500-volt paper.
C_6 — 1.0 μfd. 600-volt paper.
R_1 — 1-megohm potentiometer.
R_2, R_3 — 2.7 megohms, 1 watt.
R_4, R_5 — 1.8 megohms, 1 watt.
R_6 — 2-megohm potentiometer.
R_7 — 1 megohm, 1 watt.
R_8 — 0.5-megohm potentiometer.
R_9 — 47,000 ohms, 1 watt.
R_{10} — 0.15 megohm, 1 watt.
R_{11}, R_{13} — 1 megohm, ½ watt.
R_{12}, R_{14} — 3-megohm potentiometer.
L_1 — Final-amplifier tank coil.
RFC — Final-amplifier r.f. choke.
T_1 — Modulation transformer.
T_2 — Power transformer (about 100 volts each side c.t.).
T_3 — Filament transformer (depends upon type of 'scope tube used).

The circuit shown in Fig. 4-5 has two novel features. Accelerating voltage for the cathode-ray tube is obtained from one of the high-voltage supplies in the transmitter, eliminating the need for a separate supply. The filament voltage for the 8016 rectifier is obtained by link coupling it to the tank coil of a low-power r.f. stage. Thus during stand-by periods the 'scope tube is inoperative, eliminating the danger of burning the screen.

Since the 8016 operates at only 1.25 volts and is easily damaged by overloads, it is suggested that the initial adjustment of the link be made using a No. 112 flashlight lamp across the link in place of the 8016 filament. Use a one-turn link and start with very loose coupling. Increase the coupling until the lamp reaches full brilliance. *Caution!* The lead from the high-voltage transformer to the link must be opened during this adjustment, because otherwise the link would be at the full plate potential! All wiring associated with the 8016 filament should be insulated for several thousand volts.

Should a more conventional filament circuit be desired, any of the high-voltage rectifiers (2X2, 2V3-G, etc.) may be used with a well-insulated filament transformer. A modification of this type is shown in Fig. 4-6.

In operation, this modulation indicator pro-

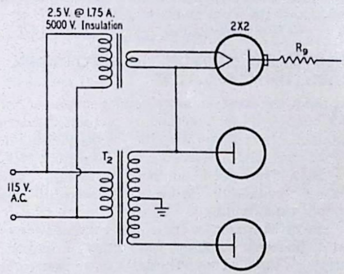


Fig. 4-6 — Alternate connections for the built-in oscilloscope when using a 2X2 high-voltage rectifier with transformer for filament supply.

duces the familiar trapezoidal pattern (in many ways superior to any other for this purpose). Should a "leaning" pattern appear, it is probable that some r.f. voltage is appearing at the horizontal-deflection plates of the tube. This effect can be minimized by insertion of a 2.5-mh. r.f. choke in the lead to the rotor arm of R_1.

General information on the adjustment and operation of cathode-ray tubes, and on the interpretation of the trapezoidal patterns obtained, may be found in *The Radio Amateur's Handbook.*

— *John V. Ellison, W4MID*

PLATE-MODULATING THE 807

In an attempt to obtain better audio response, the screen resistor in an 807 amplifier was bypassed, as shown in Fig. 4-7. The result was a very bad low-frequency parasitic that caused splatter and severe BCI. With the aid of a sensitive wavemeter similar to the one described in recent editions of the *Radio Amateur's Handbook*, the trouble-causing circuit was found to be the plate r.f. choke resonating with C_1, C_2 and C_3, building up something like the old Colpitts, with the screen acting as the control grid. The parasitic circuit is shown in heavy lines.

By-passing the lower end of the plate choke eliminated the parasitic, but the capacity

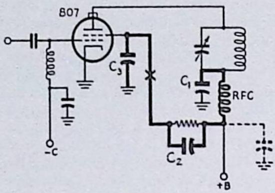


Fig. 4-7 — A plate-modulated 807 amplifier stage that was troubled with parasitics. The low-frequency parasitic circuit is shown in heavy lines. The method by which the trouble was cured is described in the text.

(dotted) had to be so large that it also by-passed enough of the audio to impair speech quality. The final solution was the insertion of a 1000-ohm resistor at the point marked "*X*."

— *Harold Bernhardt, OE-341, ex-LY1HB*

UNIVERSAL OUTPUT TRANSFORMERS USED IN MODULATOR

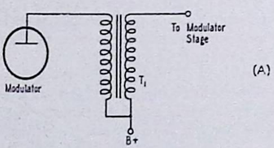
About the most common, and yet one of the more inefficient methods of plate modulating an oscillator or power amplifier, is the Heising or choke modulation system. Many amateurs seem to have overlooked the possibilities of transformer modulation utilizing replacement-type output transformers.

The usual circuit for transformer modulation of an oscillator or amplifier, when both r.f. and a.f. tubes are supplied from the same power source, is shown in Fig. 4-8A. Here, T_1 is equivalent to an autotransformer of the proper ratio, with the plate voltage fed in at the tap and the modulator and amplifier plates taken off at opposite ends.

For low-power use, advantage can be taken of universal replacement push-pull output transformers, which will satisfactorily handle the low power, in transceivers or transmitter-receivers, since a 'speaker winding is also supplied. Thus one transformer, by a judicious choice of values, can be made to take the place of two with greater output efficiency.

For example, consider a 12-watt oscillator, say a 6V6, modulated by a single Class A 6V6, with a plate-supply voltage of 300 in a circuit as shown in Fig. 4-8B. The plate current of the oscillator will be $I = W/E = 12/300 = 0.04$ ampere (40 ma.) and the equivalent resistance of the Class C circuit will be $R = E/I = 300/0.04 = 7500$ ohms. The recommended load impedance of the 6V6 modulator for 300-volt operation is 8500 ohms. This mismatch is permissible. However, in tube combinations where a 2-to-1 or 3-to-1 mismatch occurs, a compromise must be made since the most generally available transformers have symmetrical primaries. It is preferable to put the higher load resistance across the modulator, which will give less distortion than the lower value, and accept slightly less audio-power transfer to the load, since this will help guard against overmodulation.

— *Alan Sobel*



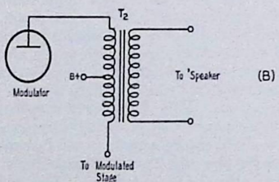


Fig. 4-8 — (A) Transformer modulation using a conventional modulation transformer. (B) Transformer modulation using a replacement-type push-pull output transformer.

LINK-COUPLED MODULATOR

Modulation transformers are quite expensive, but 'speaker output transformers of the universal type are readily available, and at low prices. Many low-power transmitters use filter chokes in the Heising circuit; others use the split primary of a 'speaker output transformer for a modulation transformer. Both of these systems have the disadvantage of having to use a common power supply for both transmitter and modulator, and permit no adjustment for proper impedance match. Also, push-pull modulator tubes cannot be used. The following scheme is superior in both respects.

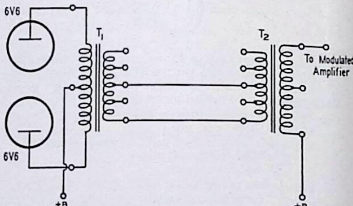


Fig. 4-9 — Universal-type output transformers connected back-to-back to obtain control over a wide range of impedances.

Use two universal 'speaker output transformers connected back-to-back, as shown in Fig. 4-9. By utilizing the voice-coil taps, a wide range of impedances can be matched; step-up or step-down, single-ended or push-pull, Class A, AB, or B. Merely determine the impedance transformation ratio for the various voice-coil taps from the data sheet supplied with the transformers. Then, by using the ratios as a step-down from the modulator and as a step-up to the transmitter, a perfect

match can be had. As an example: Push-pull Class AB 6V6s are to be used to modulate an 807 running at 400 volts and 60 ma. The recommended load resistance for 6V6s, Class AB, is 8000 ohms. The modulated amplifier represents a load of 400/0.06, or 6666 ohms. From the data sheet we find the secondary tap that will match 8000 ohms to, say, a 6-ohm voice coil. Then all that has to be done is to find from the same data sheet a tap which will match approximately 6666 ohms to a 6-ohm voice coil, the two secondaries are linked together, and the job is done with a "link-coupled" modulator at a fraction of the cost of a regular modulation transformer.

— *Harry R. Hyder, W3NVL; Joseph Vitko, W1BEA*

IMPROVED CIRCUIT FOR PREVENTING NEGATIVE-PEAK SPLATTER

Clipping is the only method that allows full modulation of the carrier at all times without negative-peak splatter. Only high-level clipping will be discussed, because it is the *only* method of clipping that is a sure preventative of negative-peak splatter. No maladjustment is possible because the operation is entirely automatic.

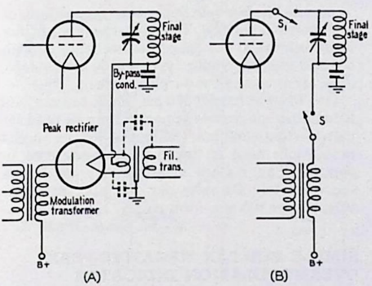


Fig. 4-10 — The usual type of high-level negative-peak clipper is shown at A. On negative peaks, the peak rectifier does not conduct, and the circuit is opened as though by S in B. With no plate voltage, the output tube is disconnected from the circuit, as though by S_1. The net effect is that the final tank circuit is hit by a negative square wave, and damped waves are generated as in a spark transmitter.

Any increase in gain after the low-level clipper, or any decrease in input to the modulated stage, can result in overmodulation. Most low-level clippers limit both the positive and negative peaks, but since the negative peak is the only troublemaker, some extension of the positive peaks is desirable, provided the modulator is capable of supplying the necessary undistorted power.

Fig. 4-10A shows the typical high-level clipper. To understand its operation consider first what causes negative-peak splatter. Under normal modulation conditions, the final tube may be considered as a stable generator and the plate tank circuit and antenna as a resonant load. At all modulation percentages below 100, the final tube as the stable generator retains control of the tank circuit and the resulting signal is sharp. When overmodulation occurs, and the plate voltage drops to zero or goes negative, the final tube loses control of the tank and load circuits, just as though it were disconnected by switch S_1 in Fig. 4-10B. At this instant we have, for all practical purposes, an old-fashioned spark transmitter consisting of an antenna, a tank circuit, and a voltage source (which in this case is the modulator). The voltage applied to the tank circuit during these periods produces damped waves, the duration of which will be proportional to the circuit Q. The spectrum occupied by these waves will be determined by the L and C of the circuit.

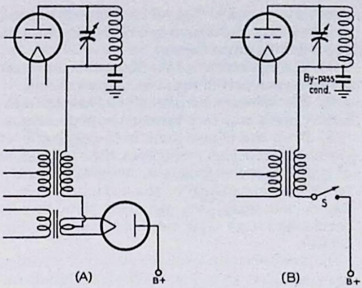


Fig. 4-11 — The new type of high-level negative-peak clipper moves the clipper tube to the other side of the modulation-transformer secondary, as shown at A. This has the action of a switch at S in B. In combination with the clipper-tube filament transformer, the inductance of the modulation-transformer secondary, and the plate by-pass condenser, a low-pass filter is formed, and no sharp negative square waves reach the modulated stage. (See Fig. 4-12.)

In operation, the clipper tube behaves the same as the final tube when the plate voltage reaches zero. It is represented by switch S in Fig. 4-10B. Thus, for all practical purposes, the tank and antenna circuits are completely disconnected from the rest of the transmitter during negative overmodulation peaks.

High-level negative-peak clipping has the following disadvantages:

1) Because of the square-wave trigger characteristics of the rectifier tube (especially the mercury-vapor type) [see following H. & K. by W6BCX — *Ed.*] high frequencies are generated which produce broad sidebands, unless the clipper is followed by a low-pass filter.

2) The filament transformer for the clipper tube must be capable of withstanding the peak modulation voltage without insulation breakdown to core or primary.

3) Capacitance of the filament-transformer secondary across the audio results in excessive by-passing.

These three disadvantages were overcome by connecting the clipper tube as in Fig. 4-11A. The

effect is as shown in Fig. 4-11B. Switch S will still disable the modulator, as in Fig. 4-10B, but with the following advantages:

1) The capacitance of the filament transformer is no longer a part of the plate by-pass circuit.

2) The voltage insulation of the filament transformer needs only to withstand the plate voltage.

3) Since the clipper tube is the generator of the undesirable high frequencies, the combination of the filament-transformer secondary capacitance, the inductance of the modulation-transformer secondary, and the final plate by-pass condenser forms a low-pass filter (refer to Fig. 4-12A).

This combination forms a constant-K π-section low-pass filter, as in Fig. 4-12B. The cut-off frequency of this filter is unimportant, so long as it is below the highest speech frequency it is desired to pass, because it attenuates only the high-order frequencies produced by the clipper tube. Similarly, the insertion loss because of the impedance characteristics of the filter is of no consequence, since the pass frequency is zero.

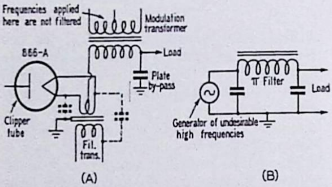


Fig. 4-12 — The circuit of Fig. 4-11A redrawn to show the filter action. The equivalent diagram is shown in B.

Assuming an inductance of 20 henrys in the modulation-transformer secondary, a capacitance of 0.002 μfd. in the filament transformer and a 0.004-μfd. plate by-pass condenser, the cut-off frequency would be approximately 900 cycles.

It must be remembered that the filter in this case need only pass direct current and attenuate frequencies below about 3000 cycles, and this allows considerable latitude. Because the cut-off frequency is well below 3000 cycles, the sloping characteristic of the constant-K configuration is of no disadvantage, for the attenuation is ample in the upper voice range and above. This eliminates the necessity for using any M-derived sections.

After the clipper has been installed, a check with the oscilloscope will prove its value. It is impossible to put a tail on the trapezoid pattern, provided that the audio applied to the horizontal plates is taken from the load side of the clipper. One of the checks used at W7NU with this clipper was to set the gain for 100-per-cent modulation with 600 watts input, and then to drop the input to 300 watts and shout into the microphone! Checks with the oscilloscope and with hams a few blocks away revealed no splatter, even with this severe test.

— *Howard W. Johnson, W7NU*

THE 836 AS A HIGH-LEVEL SPEECH CLIPPER

In the article "More on Speech Clipping" in the March, 1947, issue of *QST*, the writer showed an 866 used as a high-level speech clipper and stated that ". . . careful checks indicate that the performance is as good (with the 866) as with a high-vacuum rectifier." The 866 was used principally because it was inexpensive and could be used with a standard filament transformer.

Further investigation has shown that the high-vacuum type is more desirable, because under certain unfavorable conditions, such as location of the clipper tube in a stray r.f. field or in a region of high ambient temperature, there is a considerable slowing-up of the deionization time in the gaseous rectifier which impairs its performance. The splatter suppression is still noticeable, but is not nearly as effective as when a high-vacuum rectifier is used. Also, the transients that sometimes result under conditions of retarded deionization may, during moderately heavy clipping, cause the voice quality to sound much more "unnatural" than would otherwise be the case.

An ideal high-level clipper tube for medium or high power is the 836. This high-vacuum rectifier is not subject to the difficulties encountered with the 866 mercury-vapor type, and is available at even lower cost in the surplus market.

One 836 will handle 250 ma. input to the Class C amplifier stage; two in parallel can be used for currents up to 500 ma. Unlike the 866, no special precautions need be taken when using 836s in parallel. The voltage drop through an 836 is approximately 20 volts per 100 ma., or about 10 volts per 100 ma. for a pair.

— *W. W. Smith, W6BCX*

SIMPLE BUILT-IN NEGATIVE-PEAK OVERMODULATION INDICATOR

Here is a negative-peak overmodulation indicator suited to the needs of the laziest 'phone man. This little gimmick is so easy to build into the average 'phone rig that it is well worth the effort just to *know* that you are not filling the band with buckshot and monkey-chatter caused by overmodulation.

As shown in Fig. 4-13, the basic components required are a 1B3-GT/8016 half-wave high-vacuum rectifier and a NE-51 neon bulb. The rectifier has a filament that can be heated from almost any source, provided that about 200 ma. is available. In this unit it is heated by placing it in series with the high-voltage lead to the Class C stage, shunted by a small resistance. The value of R, somewhere in the neighborhood of 50 ohms, may be selected by measuring the voltage across the rectifier filament *ab* with the transmitter operating at normal load. *Careful!* The filament is at the full plate voltage used in the transmitter! Assuming that you run at least 180 ma. plate current to your final, the value of R should be adjusted until the drop across the recti-

fier filament is approximately 1.2 volts d.c.

The filament of the 1B3-GT/8016 has an appreciable thermal lag, so it will not be damaged by *momentary* overloads, but a good fast-acting overload relay should be used to take power off the rig in the event of a flash-over or short in the Class C stage. Resistor *R* also serves to insure a continuous load for the modulator stage even if the rectifier filament does burn out. The wattage rating of the resistor used should be large enough to handle a considerable overload. If you don't have at least 180 ma. available, the gadget won't work, because you won't be able to heat the filament.

A small positive bias is placed on the neon tube from almost any source that is available. The value of resistors R_2 and R_4, and of potentiometer R_3, should be adjusted so that about 60 volts positive appears at the point indicated in the diagram. The potentiometer may then be used to set the flashing level to any desired percentage of modulation using an oscilloscope or other modula-

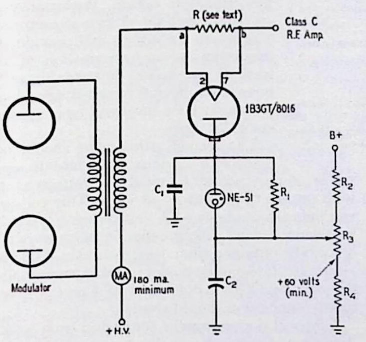


Fig. 4-13 — A simple neon-flasher modulation indicator. The circuit may be adjusted by R_3 to flash at any desired level of modulation.
C_1 — 100-μμfd. mica.
C_2 — 0.01-μfd. paper.
R_1 — 0.22 megohm, ½ watt.
R_2, R_3, R_4 — Bleeder for positive biasing NE-51. See text.

tion indicator. Since the current drain on the bias source is low, even batteries may be used.

In operation, once the desired flashing level has been set by R_3, the neon tube will flash every time you exceed that level. To be on the safe side, it should be set to flash before the 100 per cent level is reached.

— *R. Page Burr, W2KQP*

[EDITOR'S NOTE: A more elaborate overmodulation indicator is described in Chapter Eight.]

PROTECTIVE SYSTEM FOR 807 MODULATORS

THE system shown in Fig. 4-14 was worked out to give double protection to a pair of 807s used as modulators. The circuit prevents screen voltage from being applied unless plate voltage is also on, and prevents the tubes from delivering output until the output transformer is loaded.

A high-resistance relay, Ry_1, is connected so that it is actuated by the 807 plate voltage. Thus,

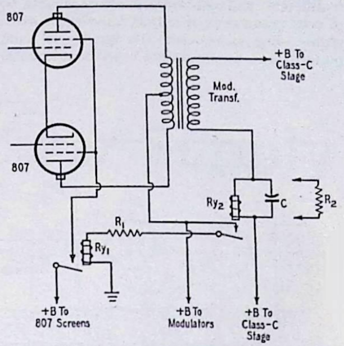


Fig. 4-14 — Protective system for 807 modulators. Two relays are used to prevent application of screen voltage before plate voltage and to kill the entire modulator if the output transformer is unloaded.
C — 8-μfd. 150-volt electrolytic.
R_1 — 0.47 megohm, 1 watt.
R_2 — See text.
Ry_1 — High-resistance relay (10,000-ohm coil).
Ry_2 — Low-resistance relay (12- or 24-volt coil).

screen voltage cannot be applied until Ry_1 closes after plate voltage is applied. The second relay is of the low-resistance type (12 or 24 volts), and is actuated by the d.c. flowing through the secondary of the modulation transformer. Thus if for some reason the plate supply to the Class C stage fails, it becomes impossible to apply power to the modulator, thus saving the modulation transformer which might break down if operated with an unloaded secondary.

If the voltage drop across Ry_2 is too great, it can be shunted as shown in the diagram. Several values should be tried until the one that produces the lowest drop while still permitting the relay to close is found.

— *Howard K. Van Jepmond, W9TJC*

A SIMPLE VOLUME COMPRESSOR

NOWADAYS it is becoming standard practice to include a compressor circuit in the speech amplifier of a rig. If you haven't already done so, a few hours of work and an investment of less than five dollars will give you the indisputable advantages of volume compression.

The circuit shown in Fig. 4-15 uses a triode-connected 6AB7 as the compressor tube. This 6AB7 should be located somewhere along the line in your speech amplifier, preferably ahead of the driver or the amplifier's output stage. It is shown as it would be connected in a resistance-coupled circuit, but it should be possible to sub-

stitute transformer coupling instead of R_2 and C_3, inasmuch as the 6AB7 is connected as a triode. At W3FPD, the lead marked "From output of speech amplifier" is connected to the hot side of the 500-ohm line connecting the speech amplifier to the modulator. If your arrangement is different, you can bridge a low-impedance tap of your modulation or output transformer with a plate-to-line transformer (its quality is unimportant, but the insulation must be adequate).

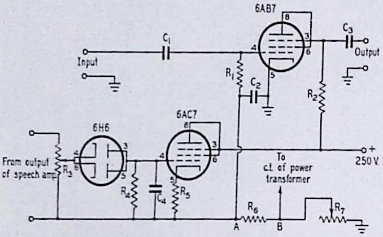


Fig. 4-15 — Wiring diagram of the simple audio volume compressor.

C_1, C_3 — 0.1-μfd. 400-volt paper.
C_2, C_4 — 0.25-μfd. 400-volt paper.
R_1, R_4 — 0.22 megohm.
R_2 — 22,000 ohms.
R_3 — 50,000-ohm potentiometer.
R_5 — 470 ohms.
R_6 — 10,000-ohm 10-watt wire-wound.
R_7 — 1000-ohm 10-watt adjustable wire-wound.

A potential of roughly 3 to 5 volts is needed at R_3 for control.

When there is no audio voltage at the output of the amplifier, the triode-connected 6AC7 bias generator has a small amount of self-bias developed across R_5. When audio voltage appears across R_3 (from the output of the speech amplifier), it is rectified by the 6H6 and applied to the grid of the 6AC7 across R_4. It appears as a negative voltage that increases with the speech-amplifier output. Hence the 6AC7 cathode current will decrease, depending upon the developed bias and the 6AC7 characteristic. Thus far we have a positive voltage with respect to ground appearing at point A, and this voltage will decrease as the output of the speech amplifier increases. But there is a (practically) constant negative voltage to ground at B developed by the steady bleed current through R_7. This voltage should always be higher than the voltage developed across R_6 by the 6AC7 current. A strong audio voltage appearing across R_3 will reduce the 6AC7 cathode current and hence the net voltage at A becomes more negative. This negative voltage, applied to the 6AB7 grid through resistor R_1, decreases the gain through the speech amplifier. The decrease in amplifier gain is proportional to the speech-amplifier output, and the desired volume-compressor action is readily accomplished.

The triode-connected 6AB7 retains the remote cut-off characteristic to a degree that is satisfactory for this application. The time delay of the circuit is determined by the combination C_4 and R_4. Capacitor C_2 should be located close to the grid of the 6AB7, to minimize coupling by the loop to extraneous noise and fields. It was also found advisable to locate the input circuit of the 6AC7 close to its source of audio drive. By observing these simple precautions, no difficulty should be experienced in adapting this device to a 'phone transmitter.

The required fixed negative bias appearing from point B to ground is obtained conveniently by inserting the variable resistor, R_7, between ground and the high-voltage center tap of the power transformer. It is assumed that the amplifier's total plate-current drain is at least 60 ma. or so. The "B"-supply voltage available to the plate circuits of the amplifier will be reduced by an amount equal to the drop across R_7. This decrease can usually be tolerated in a speech-input amplifier.

Only two simple adjustments are required. They are semipermanent and not critical to obtain. Potentiometer R_3 determines the degree of compression which the circuit will provide. A maximum power compression of at least 27 db. should be available with but a few volts of driving voltage. Thus the modulation level will be increased about 22 times.

The second adjustment should be made with no signal input into the amplifier. Simply adjust R_7 until the voltage at A with respect to ground is −3 volts. This voltage will increase to about −55 volts when the 6AC7 is driven to cut-off. Compression in the order of 27 db. will be obtained when the bias to the 6AB7 is −25 volts. If the audio power tubes of your amplifier operate Class AB instead of Class A even more compression should result.

A 50-volt d.c. voltmeter connected from point A to ground will indicate the degree of compression which the amplifier undergoes. This meter could then also serve as a modulation indicator. The slight complication of delayed a.v.c. was not considered necessary for ham use.

Practically all compressor circuits introduce some distortion, the distortion increasing with the amount of compression. Logically, for least distortion the compressor stage should be located at the front end of the speech amplifier, where the signal voltage (grid swing) is small and consequently the distortion would be minimum. However, a compromise must be made, since the tendency toward motorboating increases with the gain (number of stages) between the compressor tube and the source of the biasing voltage.

Measuring the distortion of the speech amplifier alone at 400 cycles, it was found to be 3.3 per cent at 8 watts output. With 27 db. compression the distortion was only 3.7 per cent. This small amount of distortion is negligible for all practical work, and the 27 db. of compression is a range wide enough to take care of almost any condition.

— *Jules Deitz, W3FPD*

5. Hints and Kinks . . .

for the Power Supply

OBTAINING HIGHER VOLTAGE FROM DUAL-VOLTAGE TRANSFORMERS

Many transformers have a tapped secondary to permit the simultaneous delivery of a high and a low voltage from the same unit. A circuit that permits the output voltage to equal the *sum* of the original intended d.c. voltages and has the advantage over a bridge circuit of permitting the full current rating of the high-voltage portion to be used is shown in Fig. 5-1.

With this circuit, it is possible to obtain both plate and screen voltages for a transmitting pentode or tetrode from a single supply without the use of dropping resistors, because it also furnishes power from the original low-voltage taps. The current rating of the low-voltage winding is *decreased* by the amount of current drawn from the high-voltage taps. Thus, if the simultaneous secondary rating is 300 ma., and 250 ma. is being taken from the high-voltage tap, 50 ma. is available from the low-voltage tap. The main consideration is that at no time should the primary current rating of the transformer as a whole be exceeded.

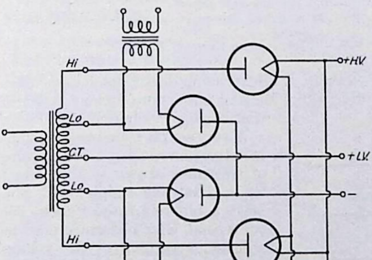


Fig. 5-1 — Novel rectifier circuit used to boost the voltage normally available from dual-tap power transformers and permitting both high and low voltages to be obtained simultaneously.

The use of three separate well-insulated filament windings is a must if fireworks are to be avoided!

— *Albert R. Orsinger, W5HUJ*

A FULL-WAVE TRANSFORMERLESS LOW-VOLTAGE SUPPLY

The 117Z6GT, a full-wave rectifier, may be used without a transformer in a low-voltage power supply, as shown in Fig. 5-2. The output of

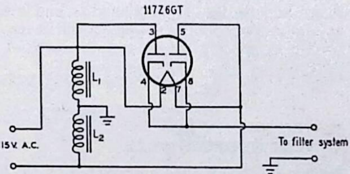


Fig. 5-2 — Low-voltage power supply requiring no transformer. L_1 and L_2 should be 10 to 20 henrys.

this arrangement has a 120-cycle ripple, thus reducing the amount of filter required. The chokes L_1 and L_2 are connected across the 115-volt line and must also carry the output current. A value of from 10 to 20 henrys is suggested for these chokes.

— *W. M. Nunn, jr.*

UTILITY POWER SUPPLY

In these days of surplus gear, miniature low-voltage tubes, d.c. relays, and gadgets requiring all sorts of odd values of plate voltage, a utility power pack for the experimenter really has to be versatile. The unit shown in Fig. 5-3 has filled the bill nicely in my shack, and I don't doubt that it will be found useful in others. It can supply a variable d.c. potential anywhere between 50 and 350 volts, 6.3 volts a.c. and 12 volts a.c.

The potentiometer, R_1, is used to set the d.c. output to whatever value is required between the limits stated above. The primary of an old 6-volt vibrator transformer is used as an auto-transformer working off the 6.3-volt winding of

the regular replacement-type transformer to obtain the 12 volts a.c. required for the filaments of so many of the surplus gadgets. A separate 6.3-volt transformer is included to supply the filaments of the 6V6 and any other gadgets requiring it.

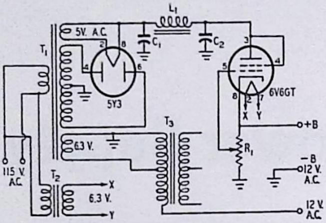


Fig. 5-3 — Circuit diagram of a handy utility power pack for the ham workbench.
C_1, C_2 — 10-µfd. 450-volt electrolytic.
R_1 — 0.25-megohm potentiometer.
L_1 — 100-ma. filter choke.
T_1 — 350-0-350-volt replacement-type power transformer with 6.3- and 5-volt a.c. windings.
T_2 — 6.3-volt filament transformer.
T_3 — Vibrator power transformer (secondary leads taped, half of primary used as shown).

The whole thing can be constructed from junk-box parts, thus keeping cost low, and it can be kept on the work bench where it will be ready to give almost any gadget you can think of a workout.

— Ralph C. Renfro, W∅KUZ

POWER SUPPLY FOR 24-VOLT SURPLUS GEAR

Much of the gear that has been offered on the surplus market was originally designed for operation from a 24-volt source. This has proved to be a headache in many respects, because hams in general have set up their stations for operation from 115 volts a.c., using 6.3-volt tubes almost exclusively. Shown in Fig. 5-4 is a small power supply that will do a very satisfactory job in furnishing plate and heater power to many of the small receivers such as the ARC-5 (SCR 274N) series, in which 12-volt tubes are used with a 24-volt supply.

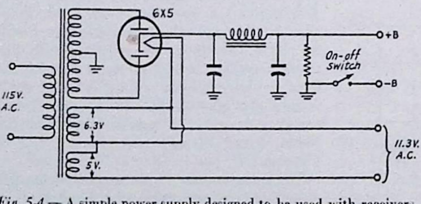


Fig. 5-4 — A simple power supply designed to be used with receivers requiring 12-volt heater supply. The filter components are standard, the only unusual feature being the use of a cathode-type rectifier to permit series connection of the two filament windings.

A standard replacement-type transformer is used with a cathode-type rectifier to permit series connection of the 5-volt rectifier filament winding and the normal 6.3-volt winding. When the plate voltage required is low, of the order of 200 or 300 volts, the hook-up shown in the diagram will be usable. It is not safe for higher voltages, however, because the cathode-to-heater potential-difference rating of the 6X5 is only 400 volts. If an on-off switch is used, it should be installed in the negative lead to the receiver rather than in the high-voltage center tap to avoid the possibility of break-down from cathode to heater in the 6X5 rectifier.

The series-connected filament windings add to 11.3 volts (when the windings are properly phased), and it is usually a simple matter to rearrange the heater wiring within the receivers to operate from the lower voltage. If rewiring is impossible, or undesirable, the 6-volt equivalent of the 12-volt tubes supplied with the receivers may be used.

— J. Richard Kearns

HIGH-VOLTAGE WARNING BLINKER

In line with the slogan "Switch to Safety," some form of warning indicator light for the high-voltage supply was needed on the transmitter at W6GM. While indicator lights are useful, one is apt to become accustomed to a steady pilot lamp and make the wrong move

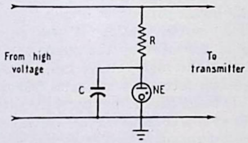


Fig. 5-5 — A neon blinker for addition to the transmitter as a high-voltage warning. The rate at which the neon tube blinks may be set by the value of the resistor used.
C — 0.5-µfd. 400-volt paper.
R — 30 megohms (three 10-megohm ½-watt units in series).
NE — ¼-watt neon lamp (G.E. NE-45).

anyway. A blinker lamp does a much more effective job of keeping one's subconscious informed that the high voltage is on.

A very simple neon blinker can be made as shown in Fig. 5-5. The value of resistance shown is about right for a 1200-volt supply, and produces a blinking rate of about one per second. This resistance must be adjusted according to the voltage of the power supply and the desired rate. If the neon light glows steadily, the resistance is too low. A clear-glass jewel should be used instead of a colored one to permit maximum effectiveness of the neon glow.

— George W. Ewing, W6GM

GETTING THE MOST OUT OF YOUR MOBILE POWER SUPPLY

Fig. 5-6 shows a method of getting the most out of a mobile power supply with the least battery drain. A 250-volt vibrator supply is used to power the oscillator and the speech amplifier, and a 500-volt dynamotor (not shown in the drawing) supplies the r.f. amplifier and the modulator.

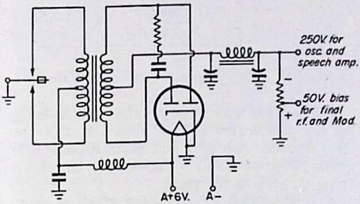


Fig. 5-6 — **Method of wiring the vibrator power supply to obtain both plate and bias voltages with maximum economy of power.**

The novelty of the circuit is that the *positive* terminal of the vibrator *output* is grounded instead of the negative. In this way, the low-voltage supply may be used as a source of bias voltage as well as a supply for the oscillator and speech amplifier.

The advantages of the system are numerous. The bias voltage does not subtract from the supply voltage, as it would in cases where the bias is obtained from a tapped grounded bleeder. The oscillator plate condenser may be grounded without requiring parallel feed, since the positive is grounded. Fixed bias may be used, without requiring batteries, eliminating the need for cathode bias. This results in a saving in the power usually lost in the cathode resistor, and permits the final amplifier to operate at the full supply voltage.

— *Zoltan T. Bogar, W3CJM*

TWO-WIRE CONNECTION FOR BIAS PACK

Two wires can be connected to the power plug of the transformerless bias pack shown in the ARRL *Handbook* without fear of a short-circuit if a s.p.d.t. switch and 115-volt lamp are connected in the circuit as shown in Fig. 5-7.

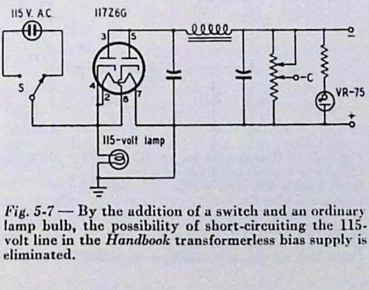


Fig. 5-7 — **By the addition of a switch and an ordinary lamp bulb, the possibility of short-circuiting the 115-volt line in the *Handbook* transformerless bias supply is eliminated.**

The switch should be thrown to the lamp position for "on" operation and the lamp will light unless the plug is incorrectly placed in the socket.

— *Walter Zuckerman, W2LBF*

FILAMENT TRANSFORMERS AS PLATE TRANSFORMERS IN BIAS SUPPLIES

It was desired to provide fixed bias on the 35T used in the final in the rig at W3FDJ, so that the plate current could be cut off during periods of no excitation while in c.w. operation. The transformerless bias supply in the *Handbook* looked good at first, but since the rig here connects to the a.c. line with the garden variety of plug, we were afraid of blowing the fuses too often because of getting the plug in the socket the wrong way, since one side of the a.c. goes directly to ground with this type supply.

To avoid this we looked for a transformer having a secondary of about 100 volts, but being unable to find one, the thought came to use a filament transformer *backward;* that is, to connect its low-voltage winding as a primary across an existing filament voltage to the 35T, and to use the normal primary for plate supply to a half-wave rectifier.

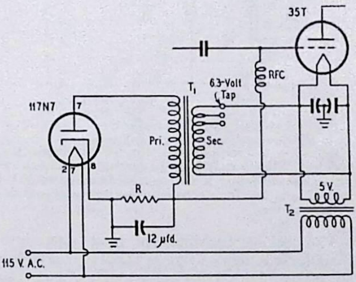


Fig. 5-8 — **A filament transformer is connected to supply grid-bias voltage through half-wave rectification. T_1 is a filament transformer with multiple taps on the secondary. T_2 is the 5-volt filament-heating transformer for the 35T. *R*, the 35T grid resistor, and a 12-µfd. condenser supply the filter action for the grid bias.**

Worked into the circuit shown in Fig. 5-8, T_1, a Thordarson T61F85 (which has a secondary tapped for 2.5, 5, and 6.3 volts at 2.5 amp.) has the secondary connected across the 5-volt supply of the 35T filament. The 6.3-volt tap is used to produce a secondary voltage of 5/6.3 times 115, or 91 volts; after half-wave rectification, this giving an output voltage across the grid resistor of about 50 to 60 volts. This was sufficient to reduce the plate current of the 35T (at 1300 volts) to about 5 or 10 ma. The rectifier section of a 117N7 was used in the bias supply, that type being on hand (we're still trying to figure out a use for the amplifier section). A 12-µfd. condenser seems to provide enough filtering. All parts are mounted on the r.f. chassis and bias

voltage is available as soon as filament voltage is applied.

Using different combinations of filament voltages and windings of transformers, various output voltages in the neighborhood of 50 to 150 volts may be obtained. Naturally, the transformer supplying the source voltage must have a rating slightly in excess of the filament current taken by the r.f. tubes.

— *William Hoos, W3FDJ*

A "SELF-POWERED" BIAS SUPPLY

SHOWN in Fig. 5-9 is a novel circuit that has been used successfully for quite some time. It eliminates the need for a fixed bias supply, yet provides fixed bias!

The VR tube is initially lighted by the grid driving voltage, and a charge is thus placed on the condenser. When excitation is removed, as when the key is up, the VR tube goes out, and the charge that remains in the condenser keeps the amplifier tube cut off.

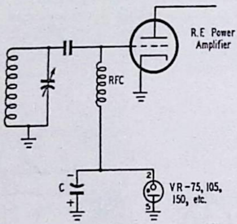


Fig. 5-9 — A "self-powered" fixed-bias circuit that requires neither batteries nor power supplies. The charge on a large condenser is used as a holding bias to do the job. C is a 20-μfd. electrolytic condenser of suitable voltage rating.

The leakage resistance of most electrolytic condensers is high enough so that the charge will not leak off for a matter of a couple of hours, so that the next time the rig is used, drive should be applied (to charge the condenser) before power is applied to the final amplifier. This is the normal procedure in tuning a transmitter anyway, so using this system should cause no inconvenience.

— *Herb Shear, W6WVQ*

A SIMPLE BIAS ISOLATOR

A COMMON trouble encountered when using bias supplies is the rise in voltage as the rectified grid current flows to ground through the bias-supply bleeder. The circuit shown in Fig. 5-10 in effect disconnects the bias supply when bias due to rectified grid current reaches a value equal to or higher than that supplied by the bias rectifier.

When excitation is applied additional voltage is developed across the grid leak, R_1. When this voltage reaches or exceeds that of the bias supply the rectifier stops conducting, no current flows in the circuit *CB*, and bias to the r.f. stage is supplied solely from the voltage developed by the flow of rectified grid current through R_1.

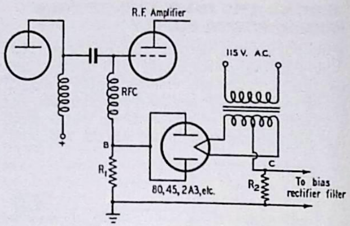


Fig. 5-10 — Easy-to-install bias isolating circuit.

The rectifier may be any nongaseous tube having low *Rp*. An 80 is ideal, but 45s, 2A3s, etc. may be used with grid and plate connected together. Pentodes and tetrodes may be used by tying all grids to the plate.

A single-ended r.f. amplifier stage is shown, but the system works equally well with push-pull. Additional stages may be supplied by connecting the bias-isolator cathodes to point *C*.

— *Wesley M. Bell, W9FEG*

SELENIUM RECTIFIERS AS A BIAS SOURCE

WITH several manufacturers including midget selenium rectifiers in their postwar lines, the amateur now has a means of obtaining protective bias for his rig without having to build separate bulky supplies. The compactness of these new units makes it entirely practical for one to be used at the base of the tube requiring the bias. The 813 amplifier in use at this station has a grid circuit as shown in Fig. 5-11. A small selenium rectifier is used in a half-wave circuit, filtered by C_1, C_2 and *L*. Values are dependent, of course, on the particular application, but for the 813 the values shown below the diagram have worked out very nicely. About 80 volts of fixed bias is always present at the grid of the tube, and the additional few volts required for operating bias are obtained by the series grid leak, R_1. In my case, bias increases to about 130 volts when ex-

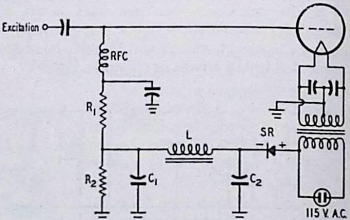


Fig. 5-11 — Bias system for an 813 amplifier using one of the new midget selenium rectifiers.

C_1 — Dual 8-μfd. electrolytic.
C_2 — Section of C_1.
R_1 — 2500 ohms, 2 watts.
R_2 — 5000 ohms, 10 watts.
L — 30-hy. 30-ma. filter choke.
SR — Federal Tel. & Radio Type 403D2625.

citation is present, varying, of course, with the amount of grid current flowing at the time.

Since only one side of the a.c. line is tapped, a good earth ground to the transmitter chassis is a requirement, and the power plug should be polarized to assure that the bias lead will always be the hot lead.

— *R. D. Althaus, W3KGD*

SELENIUM RECTIFIER HINTS

The following will be helpful in prolonging the life of the new midget selenium rectifiers:

The rectifiers should be mounted with their "fins" vertical to prevent heat from the lower sections causing destruction of the upper section.

The use of a current-limiting resistor of 50 ohms or so immediately after the rectifier will limit the initial surge into the large input filter capacitor usually used with such gadgets.

— *Laurence Geis, WØOKF*

RELAY-COIL TRANSIENT REDUCTION

After I installed a Model 750 Advance overload relay in series with a ground return from my final amplifier, I found that when I adjusted it to kick out at 320 ma., under steady-state conditions, it would not handle the transients attributable to normal turning on and off of the plate power supply. If I adjusted the threshold so that it would withstand the transient voltages, then it would not kick out, except under extreme conditions of steady overload. Since the d.c. resistance of the relay coil was only 6 ohms, I was afraid that I might have trouble slowing down the transient, especially since I did not know what the waveform of the transient looked like. To be on the safe side, I shunted the field coil with a 3000-μfd. 10-volt Mallory condenser, and found that the transient was completely tamed. It is quite possible that a lower value of capacitance would do the same trick.

— *D. W. Atchley, jr., W1HKK*

COMBINATION BIAS SUPPLY AND STATION CONTROL SYSTEM

The circuit shown in Fig. 5-12 makes use of several 24-volt d.c.-operated relays and a transformerless bias supply in an arrangement suitable for use with a low-power transmitter that uses 6L6s or 807s in the final amplifier. The relays are currently available at small cost in the surplus market.

As shown in the diagram, the coils of the relays are connected in series, and are used as a tapped bleeder across the bias supply. A 2500-ohm resistor is used to reduce the current through the coils to a point below that required for them to throw. A toggle switch shorts this resistance, causing the relays to throw to turn the transmitter on. The voltage drop across each relay coil may be used as a source of bias voltage in cases where the grid-current requirements of the transmitter are low. The voltages indicated in the diagram are typical of those obtained. When the switch is thrown to the receive position, the bias voltage increases above these figures, because the drain on the rectifier is then reduced.

Since the relay coils are connected in series, damage to the transmitter in case of bias failure is prevented, as the relays will not close. Similarly, if the coil of one relay opens, power cannot be applied to one part of the transmitter while it is not applied to another.

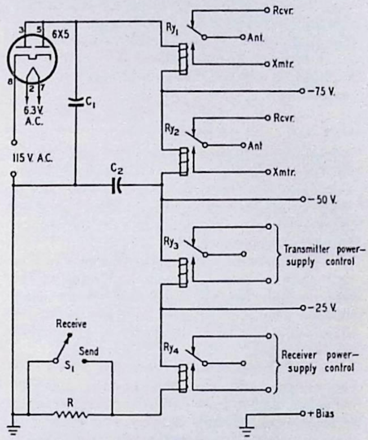


Fig. 5-12 — A novel method of using surplus low-voltage relays in a bias and station control circuit for the low-power rig.
C_1, C_2 — 20-μfd 150-volt electrolytic.
R — 2500 ohms, 10 watts.
Ry_1, Ry_2, Ry_3, Ry_4 — See text.
S_1 — S.p.s.t. toggle switch.

With the transformerless supply shown, a polarized a.c. plug must be used. There is no reason why the series-connected relay idea cannot be used with the standard transformer-type supply however.

— *Rod Grant*

A SIMPLE TIME-DELAY CIRCUIT

The time-delay arrangement shown in Fig. 5-13 depends for its operation on the time required for a heater-type rectifier tube to reach

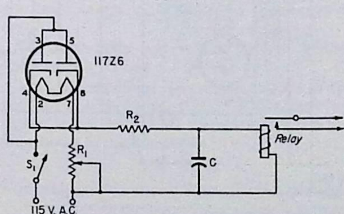


Fig. 5-13 — A simple variable time-delay system.

operating temperature. A 117Z6 is shown, but a 50L6, with grids and plate tied together, also worked satisfactorily.

A 400-ohm 10-watt potentiometer, R_1, is connected in series with the rectifier heater, to control the time delay, which is variable between 15 seconds and about one minute. R_2 is used to limit the current through the relay to the rated value. I found that 10,000 ohms was right for the relay I had on hand, as it allowed 8 ma. to flow through the relay at full operating temperature. The relay closed at 6 ma. The relay should have a d.c. resistance of from 1000 to 2000 ohms. The condenser is a 30-μfd. filter, used to prevent relay chatter.

— *James D. Matthews*

AFTER trying the above-mentioned kink, H. H. Cross, W1OOP, writes: "I found that substituting a 5Z4 for a 5U4G in the bias supply of my transmitter (using bias interlock) gave me 30 seconds' protective delay in case the regular time-delay relay failed.

"The up-to-temperature time of heater-type rectifiers is increased by poor regulation of the heater supply but the tubes furnish the same emission when hot. Heaters have low resistance when cold and heat more slowly in a constant-current circuit.

"A 25Z5, with its heater in series with a 350-ohm resistor, will take 40 seconds to reach 90 per cent emission. I use an 8-μfd. condenser input and run 60 ma. through the relay. It'll work every time and the tube will last much longer than a 117-volt type."

AN UNUSUAL RECTIFIER CIRCUIT

THE rectifier circuit to be described was originated at W1NVH and used successfully for nearly two years prior to the war. Other amateurs who have seen and used it have been so enthusiastic that it is presented here for general circulation.

The most interesting of the new circuit's many advantages and possibilities is that it offers the amateur a chance to obtain a selection of more-desirable voltages with the power-supply equipment already at hand. No longer need he be stuck with, for example, 1750 volts, when a full 2000 volts is desired. In such a case it is only necessary to add a relatively inexpensive transformer to make up the voltage deficit. The same circuit also provides for easy selection of several reduced voltages by steps, for use while tuning the transmitter and communicating over short distances.

The complete circuit is a combination of the conventional full-wave center-tap rectifier circuit and another one which at first appears unorthodox. It is shown later in Fig. 5-16, being first developed by stages for easier understanding.

In order to establish symbols and to facilitate explanation, the part of the circuit which is the conventional rectifier circuit is reproduced here in Fig. 5-14. A technical description of its operation can be found in *The Radio Amateur's Handbook* as well as numerous other radio texts.

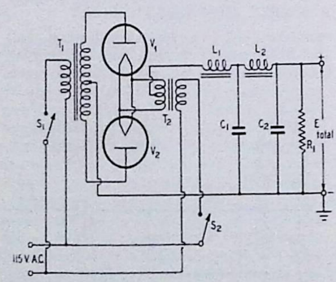


Fig. 5-14 — The conventional center-tap rectifier circuit, with choke-input two-section filter and bleeder.

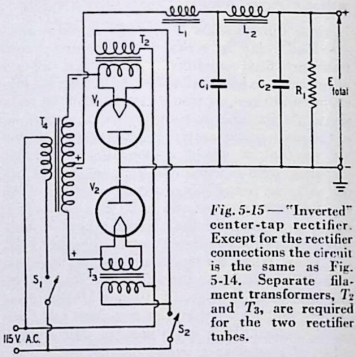


Fig. 5-15 — "Inverted" center-tap rectifier. Except for the rectifier connections the circuit is the same as Fig. 5-14. Separate filament transformers, T_2 and T_3, are required for the two rectifier tubes.

The part of the circuit which appears to be unorthodox is shown in Fig. 5-15. Don't worry, it works! In fact, it is frequently used in synchronous-vibrator power supplies, although infrequently employed with tube rectifiers. The symbols are the same as in Fig. 5-14 except that the high-voltage transformer is marked T_4. T_2 and T_3 must be *separate* filament windings because the entire secondary voltage of T_4 is between them.

It can be seen upon examination that this circuit is simply an inversion of the more conventional one of Fig. 5-14. It can be used alone and possesses a number of advantages over the standard one, such as:

a) It reduces hazards because the plate caps on such rectifier tubes as 866s and 872s can be at or near ground potential. The number of exposed high-tension leads is minimized.

b) Ripple voltage in the output has always been found to be less. If T_2 and T_3 are not center-tapped, experimentally connect the secondary of T_4 to either side of these individual windings

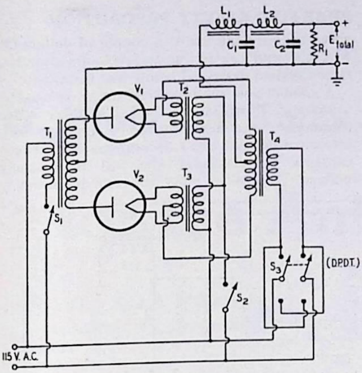


Fig. 5-16 — The new circuit combines Figs. 5-14 and 5-15 to make four different output voltages available, depending upon whether each transformer is used alone or whether the two are used together aiding or opposing. The d.p.d.t. switch, S_3, reverses the line connections to the primary of one transformer to reverse its secondary phase with respect to the other. Filter constants are the same as for conventional power supplies of the same voltage and current ratings.

for least ripple voltage. However, the difference in ripple is not important in ordinary use.

c) There is less trouble from r.f. getting into the power supply. This is because the high-potential leads of transformer T_4 are by-passed to ground for r.f. by the secondary-to-primary capacitance of the windings of T_2 and T_3. Also, the plates of V_1 and V_2 are at or near ground potential.

d) It permits cheaper grounded-anode cooling methods for heavy-duty rectifiers.

A brief technical analysis of the circuit is made easy simply by following the paths of the electrons through the various elements. Referring to Fig. 5-15, note the positive and negative signs shown at the terminals of the secondary of T_4. These are given for a particular instant (or half cycle) when the upper half of T_4 is operating so as to impress a negative potential upon the cathode of V_1. You must then agree that the center tap of this winding is positive at this same instant. Since electrons can flow through V_1 only in one direction — that is, from filament to the plate — the supply of electrons from the negative potential readily flows across the tube to the plate, which is positive because it is connected to the positive end of the half-winding (center tap) via the load resistor, R_1. It should also be observed that the lower half of the secondary of T_4 cannot function at this time because the plate of V_2 is negative with respect to its cathode through the load.

The final circuit is developed by combining Figs. 5-14 and 5-15 as shown in Fig. 5-16. For all practical purposes we have merely added another plate transformer, T_4, to the old rectifier (not counting extra filament windings). Because the lower-voltage transformer usually has poorer insulation, it is advantageous to place it in the T_1 position where it can be kept close to ground potential.

The following statements hold true:

a) The total output voltage is the sum of the voltages separately obtainable from T_1 and T_4 if these transformers are connected in phase to the power line. This can be experimentally determined by transposing the primary leads to the power line to obtain the greater output voltage.

b) The total output voltage is the difference between the voltages separately obtainable from T_1 and T_4 if the transformers are connected out of phase to the power line.

c) When the system is operating as in (b) there is no undue loss of efficiency because only the resultant voltage and not each of the canceling voltages is rectified.

d) The polarity of the d.c. voltage delivered to the load R_1 will always be the same regardless of the transformer switch connections. In other words, the positive output lead will never shift position.

e) The total output voltage is only the voltage obtainable from T_1 alone if the primary of T_4 is opened.

f) The total output voltage is only the voltage obtainable from T_4 alone if the primary of T_1 is opened.

g) The secondary of the "dead" transformer in (e) and (f) acts as an additional smoothing choke and as part of the filter circuit.

The switches shown in Fig. 5-16 provide the four different output voltages mentioned in (a), (b), (d), and (e) above. It goes without saying that all components must be designed for the power and insulation requirements of the circuit involved.

— *Comdr. E. E. Comstock, USCG*

"FREE" BLEEDER FOR C.W. TRANSMITTER POWER SUPPLIES

If your r.f. amplifier stage is properly neutralized, you can allow it to draw plate current under key-up conditions and save in three ways:

1) Greatly reduce the size and cost of the bleeder resistor.

2) Reduce the key-down drain on the power supply, thereby allowing transformers and chokes of lower current rating to be used. (Or get more useful current out of your present supply.)

3) Reduce the power bill through greater power-supply efficiency.

For good regulation, the bleeder resistor at the output of a choke-input filter is generally accepted to be about 1000 times the value of the inductance of the first choke.[1]

$$R = 1000L$$

Now suppose you have a 2000-volt power supply

[1] Dellenbaugh and Quimby, "The Important First Choke in High-Voltage Rectifier Circuits," *QST*, February, 1932.

with a 20-henry input choke. The bleeder resistor is 1000 × 20 or 20,000 ohms. The bleeder current is E/R or 100 ma., and the bleeder power is I^2R, or about *200 watts!* Two things are at once apparent:

1) A resistor of such high power rating is quite expensive.

2) The power supply is delivering 200 watts more than is necessary when the key is down, and this power serves no useful purpose other than to heat the shack.

If, for example, we connect this supply to a pair of RK-48s or 813s in push-pull, we know that with the key up, the supply delivers 100 ma. to the bleeder. With the key down the tubes draw 360 ma. The total load on the supply is 460 ma. with about 22 per cent of it wasted in the bleeder.

Now if we eliminate the bleeder (and connect a few-hundred-thousand ohms resistance in its place for safety), and adjust the bias on the amplifier tubes so they draw 100 ma. with the key up,[2] the following conditions will prevail:

With the key up:

1) The tubes act as the bleeder.

2) Rated plate dissipation is not exceeded, and tube life is not shortened.

3) The only bleeder required is a low-wattage fairly-high-resistance unit to discharge the capacitors when the power is off.

With the key down:

1) The power supply delivers 360 ma. to the tubes, and a negligible amount to the "safety" resistor.

2) Substantially all current delivered by the supply is used by the tubes for generating r.f. power.

3) The lights will blink less when the key is closed, because the *change* in current is now only 260 ma. (instead of 360 ma. as before).

Following the idea outlined here, the bleeder resistor current can be reduced or substantially eliminated under key-down conditions. The wattage rating of the resistor will be greatly reduced in any power supply feeding any r.f. amplifier. Be sure to remember these precautions:

1) Do not exceed the rated plate dissipation of the tube. (Plate dissipation with the tube acting as the bleeder is the power-supply voltage times the key-up plate current.)

2) Always have a few-hundred-thousand ohms connected across the filter, to discharge the condensers when the power is turned off.

3) Always make sure the condensers have discharged before you change coils or tubes.[3]

— *George L. Downs, W1CT*

[2] They won't oscillate if properly neutralized. For a note on these particular tubes, see page 17, May, 1947, *QST*.—Ed.

[3] In this connection, a voltmeter makes a good low-current bleeder while providing an indication of the charge left in the condensers.—Ed.

SURE-FIRE SAFETY PRECAUTION

For the expenditure of a couple of dollars for a relay and a switch, and a few hours labor, the safety system described below was installed.

A double-pole double-throw relay is used in the circuit shown in Fig. 5-17. The relay is one commonly used for antenna switching, with ceramic insulation and sufficient spacing between contacts to withstand the full plate-supply voltage. One set of relay contacts immediately grounds the B+ voltage when the transmitter switch is turned off, and the other set energizes a green panel light, signifying that it is safe to touch the final tank coil. This safety signal will not operate until the B+ is actually grounded; thus if the relay fails to operate, the green light will not come on, and the operator knows that danger is present. The red panel light is turned on whenever the transmitter switch is turned on.

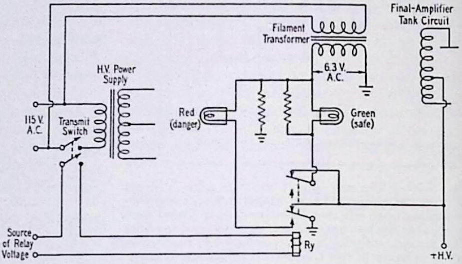


Fig. 5-17 — Safety circuit used to ground the plate supply when the "send" switch is turned off. The relay used is described in the text.

Because relays sometimes do not throw as they should, it is possible that the path to ground from B+ may (instantaneously) be through the pilot light and the filament winding. For this reason, a filament winding separate from any tube circuit is advised. Good insulation should be used on the lead from the relay to the green lamp to eliminate the possibility of a short to ground, which would cause the green signal to light. The key to the system: If the red light is on, stay away! If the green light is on, it is safe to touch the final tank coil. If neither light is on, or if both lights are on, something is haywire, and it will pay to ground the tank before touching it.

— *Charles F. Lober, W8ICO*

TIE-STRAPS FOR FILTER CONDENSERS

Here's an easy way to mount those surplus filter condensers which invariably come through without brackets. Take a pair of old bicycle spokes and, measuring from the threaded end, cut them slightly longer than the height of the condenser. Bend the unthreaded end of each into a hook to fit snugly on the shoulder of the can. All that remains is to feed the threaded ends through the chassis, affix the spoke nuts, and tighten.

— *Lyman H. Howe, W2TJH*

6. Hints and Kinks . . .

for the Antenna System

JUNK-YARD BEAM ROTATOR

A very satisfactory beam-rotating mechanism can be made from an old screw jack by the method shown in Fig. 6-1. The jack can be obtained for next to nothing in almost any junk yard or auto-wrecking lot

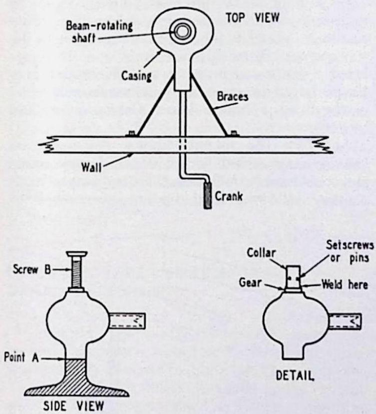


Fig. 6-1 — Here's the novel beam-rotating gadget used at W1OPW. Made entirely of junk parts, it can be assembled and installed in a few hours.

Have a welder cut the casing at point *A*, and discard the portion that is shaded in the side view. Then have him cut screw *B* so that it can be threaded out through the bottom of the casing. This leaves the gear structure intact. One gear protrudes through the top of the casing and rotates 360 degrees in the horizontal plane when the crank handle is turned. Have a collar made from a piece of pipe welded on this gear as shown. It will then serve as a socket for the base of the shaft that rotates the beam. The shaft should be pinned inside of the collar to prevent slippage.

Braces to provide mounting supports are then welded to the outside of the gear casing as shown in the top view. The crank handle may be run through the wall to the inside of the shack where a direction indicator may be attached if desired.

This mechanism has been in use for several months and has provided trouble-free operation, even when it was covered with a thick coating of ice and snow. In addition to the low cost and simplicity of construction, it is superior to many motor-driven systems because it permits the speed of rotation of the beam to be changed to suit the operator's convenience. All he has to do to get the beam around in a hurry is crank a little faster!

— *George Rossetti, W1OPW*

CLEARING JAMMED PULLEYS

One of my antenna pulleys had gotten gummed up or rusty and was becoming hard to operate. The pulley was at the top of a 42-foot mast that could not be lowered or climbed. Here's a hint to others faced with the same unhappy problem.

I folded a piece of waxed paper diagonally a couple of times, forming a triangular sack. I then poured several ounces of heavy motor oil in the sack, gathered the top together with string, and lashed the whole sack to a point on the antenna halyard that I knew I could pull through the pulley. The halyard was then pulled until the sack was four or five inches from the pulley, as

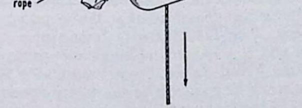


Fig. 6-2 — A clever method of oiling a pulley at the top of an antenna mast. A breakable sack is made of wax paper and is then filled with oil. It is smashed against the pulley block with a quick yank, drenching the block with the oil.

shown in Fig. 6-2. A quick yank on the halyard then smashed the paper sack, causing the oil to drench the pulley block thoroughly, giving it the bath that it needed to clear up the trouble.

— *Robert E. Barr, W5GHF*

WEATHERPROOFING TWIN-LEAD

Shown in Fig. 6-3 is the scheme used by W5CXS, W6PNO and XE1KE to avoid the detuning effects often encountered in wet weather with Twin-Lead feed lines. Slots are cut in the

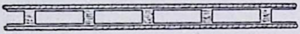


Fig. 6-3 — Method of "weatherproofing" feed lines made of Twin-Lead. Some of the dielectric is removed, leaving only enough to maintain line spacing.

dielectric between wires, leaving just enough to serve as normal feeder spreaders and to provide enough mechanical strength to hold the spacing rigid. W5CXS suggests that the slots be cut about 1½ inches long.

A REVERSIBLE FIXED BEAM FOR TEN

For some time the writer used a horizontal folded dipole in the 28-Mc. band, and while signals were received with good intensity, objectionable interference was also received from the direction opposite to that of the desired signal. Because of the difficulty of erecting rotating mechanisms, a rotary beam was out of the question. In the mornings we wanted contacts ranging from the north of Scotland through the Mediterranean to South Africa, and in the evenings with stations in the Pacific, Australia and New Zealand. Obviously, it was undesirable to construct a sharp fixed beam that would lay a satisfactory signal into England but would not be very effective to South Africa. Also, in this particular residential district elaborate aerial structures are not entirely appreciated.

After a number of sheets of scratch paper had been filled and thrown in the wastebasket, there finally evolved what appeared, to the writer, to be a simple answer to his problem. The existing folded dipole, which was 30 feet above ground and constructed of heavy antenna wire with a spacing between the upper and lower conductors of six inches, was allowed to remain as originally constructed. An additional folded dipole, identical with the first, was constructed and the two dipoles were held 8 feet and 1 inch apart by spreaders about 8 feet 4 inches long. In other words, the two folded dipoles were placed in the same horizontal plane, parallel to each other and a quarter wavelength apart at the operating frequency. Twin-Lead 300-ohm transmission lines — *A* and *B* — *of identical length* were connected to each folded dipole. These transmission lines were made long enough to run to the operating room in the basement. Care was taken to assure that each transmission line was dropped away from its folded dipole at right angles for a distance of at least a quarter wavelength and that the two Amphenol Twin-Leads were spaced two feet throughout wherever possible. At W4SN this spacing is held except that a spacing of approximately 9 inches exists where they enter the operating room. At a convenient point in the shack the transmission lines are brought to opposite ends of a d.p.d.t. porcelain-based switch as shown in Fig. 6-4. The mechanical junction or bar between the switch arms is reinsulated with high-frequency insulating material for minimum losses. A quarter-wave phasing section of 300-ohm line is connected between the ends of the d.p.d.t. switch. Its length, *l*, equals a quarter wave at the operating frequency times the propagation factor of 0.84. From the switch arms a length of 150-ohm line is run to the antenna send-receive relay and from this point 150-ohm Twin-Lead is run, respectively, to the transmitter coupling link and to the receiver input terminals.

After construction of this antenna it was necessary to check for proper polarization. First, a signal was tuned in which appeared to be on a line perpendicular to the direction in which the folded dipoles were horizontally located. With the signal about S4 on the receiver as adjusted by the r.f. gain control, the d.p.d.t. switch was thrown from one position to the other to determine whether an appreciable difference in signal strength resulted from changing the switch position. The transmission-line connections of *one* antenna may be reversed at the d.p.d.t. switch to determine which connection produces the greatest front-to-back ratio; the connection producing the greatest figure is the correct one. If everything is connected properly and the station is in the preferred direction, a considerable increase — on the order of three or four S divisions — should be noted.

Although the folded dipoles described are heavily constructed to withstand heavy winds and considerable buffeting, there appears to be no reason why two folded dipoles constructed en-

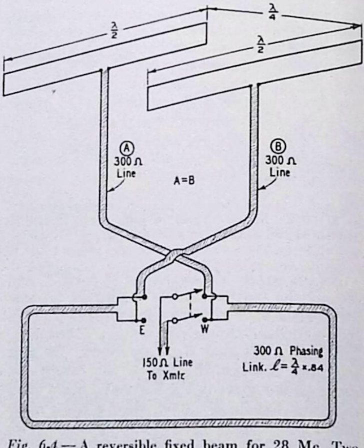


Fig. 6-4 — A reversible fixed beam for 28 Mc. Two folded dipoles are mounted a quarter wavelength apart and are fed with 300-ohm line. The directivity is made reversible by a double-pole double-throw switch as shown. Forward gain is approximately 5 db., and the front-to-back ratio is approximately 20 db.

tirely of 300-ohm line would not serve, during periods of light winds or in protected areas. Greater frequency coverage (within a given band) may result from the use of open-wire construction than with 300-ohm line, but for those who do not operate over a wide frequency range little difference should be noticed. Parenthetically, it may be stated that with the antenna arrangement in use at W4SN little change in antenna loading is observed between 28 and 29.4 Mc. Reception is quite satisfactory throughout the ten-meter band.

Phasing of two folded dipoles constructed to operate on the 20-, 40- or 80-meter bands should be satisfactory and should be productive of results. The physical requirements of support, spacing and arrangement of antennas and phasing stub will be proportionately greater than for a ten-meter antenna but, theoretically, the antenna is practical on any band.

Experience at W4SN indicates that this antenna gives a worth-while gain over an azimuthal area of approximately 75 degrees. The horizontal pattern produced by this array, simple though it is, approximates a cardioid. With the assistance of W4ILF and other amateur stations with whom tests were made, the front-to-back ratio was measured to be of the order of 20 db.; the forward gain is approximately 5 db. The addition of this folded dipole and the phasing arrangement shown in Fig. 6-4 made a worth-while improvement in the signal transmitted by our little 25-watter, and has accomplished a very encouraging reduction in interference from other stations operating on the same frequency in a direction opposite to Europe, in the mornings, and Australia and New Zealand, in the evenings.

— *Stacy W. Norman, W4SN*

"FLUTTER" PREVENTION FOR BEAM ANTENNAS

To eliminate wind "flutter" of rotary-beam elements (especially 20-meter center-supported "plumber's delights"), slip wood strips inside of the elements to damp out the vibrations. The strips should not be fastened down, but the ends of the elements may be either plugged or deformed to keep the strips from sliding out. You'll find that the strips rattle around a little when the wind blows, but the elements show no signs of getting the jitters.

In my own beam the elements are made of 1¼-inch ST61 tubing supported from a 2½-inch square boom. Before treatment the beam had a terrific flutter which shook the elements, the boom, the tower, and the house. Strips 3/16-inch square and 10 feet long were slipped inside of each element, and the ends were plugged. From that time on the problem ceased to exist.

— *William Vandermay, W7DET*

A VERSATILE PORTABLE ANTENNA SYSTEM

The antenna "system" shown in Fig. 6-5 was developed for portable use as a means of avoiding antenna troubles that had been encountered in considerable experience operating as a portable station. It has proved to be quite versatile, and saves a great deal of the time usually consumed preparing the antenna required for a particular site.

The system makes use of three 66-foot lengths

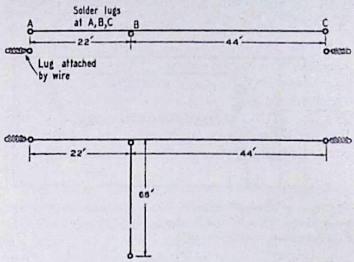


Fig. 6-5 — A timesaving portable antenna system. Three 66-foot lengths of wire are prepared in advance, making it possible to put up an antenna in jig time.

of rubber-covered "lead-in" wire. Soldering lugs are attached to each end of each length, and a third lug is connected to a point 22 feet from one end. Two ordinary glass insulators, each fitted with a lug at one end, and a few 6-32 nuts and bolts complete the equipment required.

If a 40-meter end-fed wire is desired, an insulator is fastened to one end of one of the 66-foot lengths by bolting the lug to the lug on the insulator. The other end of the wire is connected to the transmitter. If an off-center-fed antenna is called for, both ends of one 66-foot length are connected to insulators, and one of the other wires is connected to the lug that is 22 feet from one end of the piece used as the flat top.

For 80-meter operation, two lengths are connected end-to-end, and the feeder connected as described above. The fact that all wires are equipped with lugs makes for rapid installation and insures good contact without soldering. The flexible wire is preferred, as it is almost kinkless.

— *E. G. Brooner*

INEXPENSIVE FEEDER SPREADERS

While watching my XYL giving our little girl a home permanent, I found a source of inexpensive 2-inch spreaders. The plastic curlers from a "Toni" home permanent are ready-made spacers and cost only about two cents each. In my case I drilled out the inner holes and threaded in my feeder wires. The outer forked tongue holds the tie-wires.

— *Thomas W. Wing, W6MVK*

Here at W8PSV I use 14-inch knitting needles, cut in half, for my 7-inch open-wire line. They are light, fairly strong, and easy on the pocketbook.

— *Harry Stewart, W8PSV*

WIRE-SAVING IDEA FOR "SELSYN" USERS

It is often difficult to obtain a five-wire cable to connect synchro motors. This problem is simplified somewhat, however, by the fact that separate windings are used in the motors, thus permitting one wire to be used as a common lead serving both the line circuit and one of the delta circuits, as shown in Fig. 6-6.

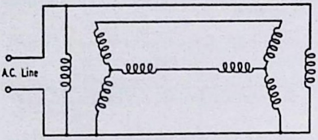


Fig. 6-6 — Method of using four wires instead of five to connect "Selsyn" indicators. One wire is used as a common lead in two circuits.

For indoor and temporary installations, two lengths of ordinary lamp cord may be used. If you want to reverse the direction in which one motor shaft turns, merely reverse the connections of any two of the three delta wires.

— *Roy A. Long, W6YBL*

A 40-FOOT TOWER FOR THIRTY DOLLARS

Antenna trouble, mate? Then lend an ear to a plan for a sky hook that's simple and cheap to build, yet strong enough to withstand sleet, windstorms and other inclemencies of the weather. The idea was borrowed from steel towers used in constructing the Allatoona Dam in North Georgia. Those 100-foot towers were unusually strong, capable of supporting 40-ton buckets of concrete between them.

The antenna mast, shown in Figs. 6-7 and 6-8, is a small replica of the construction tower. It looks like a 40-foot-high vine trellis, one foot square in cross section, with fourteen 3-foot 1 × 2s nailed zigzag fashion from bottom to top on four sides. The whole structure weighs only 180 pounds.

The unusual feature of this tower is the simplicity of construction. Some towers decrease in width and breadth as you build toward the top but in this case width and breadth are uniform and cross boards are all the same size, thereby saving you a lot of time measuring and sawing.

Construction

To construct the mast, lay out two sides first. Get twelve 15-foot 2 × 2s, three for each corner. Splice each three of them with 8-foot 1 × 2s, and you have four 45-foot pieces. Nail the fourteen 3-foot 1 × 2s zigzag fashion between each pair of the 45-foot lengths. The distance between each pair of long pieces is now one foot. Then nail 1-foot braces across the sides at the bottom, middle and top, three on each side.

The two sides are now ready to be put together — with more of the 3-foot 1 × 2s and short braces. When finished, you will have fourteen zigzag 1 × 2s and three braces from top to bottom on each side.

The ladder comes next, and then the paint. Future builders of such towers can profit by the writer's experience in two respects. First, put the ladder on the outside rather than on the inside of the structure! While having it on the inside may add to the beauty of the finished product, the pressure of climbing feet slowly presses the steps away from the corner pieces and in time weakens the nails to the danger point. Use conveniently-spaced short 1 × 2s for the ladder.

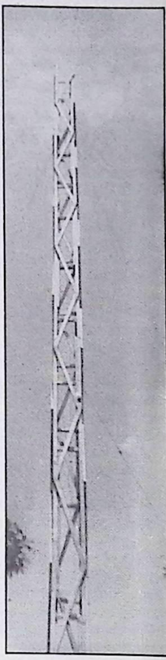


Fig. 6-7 — The finished tower.

The finished tower was painted with white creosote. White was fine, probably the best color for outside work of this type. However, the creosote flaked and peeled in about six months, making it necessary to repaint the tower with more durable outside white house paint. So use house paint the first time.

The tower uses two sets of guy wires, four from the top to support the structure and four from the middle to prevent sympathetic vibration.

First, level the site for the base. Iron stakes driven into the bedrock and bolted to the tower will help steady it. Lay bricks level within the iron stakes for the wooden mast to rest on, to discourage termites.

Now for erecting the tower. In spite of the light weight, its shape calls for the strength of six men to stand it on end. A gin pole and block-and-tackle simplify the job of getting the tower up the last 60 degrees. When it is up, tighten the guy wires and the job is finished. Hang your antenna on it, and all is set.

The long pieces for your corner posts, white pine, should run about $7. The rest of the lumber, crosspieces, bracers and splicers, will be about $10. Paint, one gallon of good-grade outside white, costs $5.40. New stranded stainless-steel wire (enough for this job) runs about $5.60. Also, you will have to invest in some strain insulators for your guy wires.

Although this totals $30, you should be able to build this tower for half the price if you dig around in the secondhand lumber piles of wrecking companies.

The tower is strong, stable and sturdy in all types of weather, including heavy wind. The tower shown in the photograph completed its second winter with flying colors — no sign of weakness in spite of much sleet and many windstorms. Such a tower should last as long as a house built of similar materials.

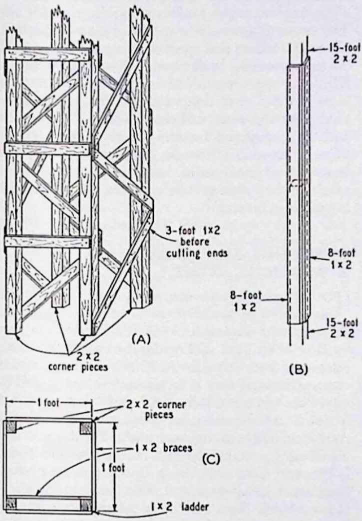


Fig. 6-8 — Details of the tower construction. The general assembly is shown at A, with a cross-sectional view at C. The method of joining the 2 × 2 corner posts is shown in B.

And when you want to paint again, don't hesitate to climb to the top. True, it seems risky to climb a 1 × 1 × 40-foot structure, but don't be afraid — it is stable. No "rocking" was detected when the job was done at W4HYR. Stable, weatherworthy and cheap, this tower is well worth your time and money to build.

— *W. C. Rippy, jr., W4HYR*

A COUNTERBALANCED TOWER

Adjusting a rotatable antenna, once it has been installed on top of the tower, is always a difficult if not hazardous undertaking. By the time one has climbed to the top of a 40- or 50-footer a half-dozen times, he usually loses his enthusiasm for an on-the-nose trim and is content to let it ride as it is. After six or seven years of this, we decided to see what could be done to improve the situation. One idea we had considered was a scheme for tilting the tower to ground for antenna adjustments and repairs.

The tower, patterned after a *QST* design of several years ago, is a tapering 40-foot four-legged lattice structure. To determine the feasibility of a counterbalanced arrangement, the tower was lowered to the ground. A point 16 feet from the base was selected as the most convenient spot for the hinge or pivot. Accordingly the mast was propped up on a length of 2 × 4 which served as a fulcrum at this point. Known weights, such as buckets of water, sacks of cement and the author's own weight, were used to simulate actual conditions. A 50-pound weight, representing the antenna, was placed at the top end of the mast and then counterweights were added at the bottom end to balance. It was found that the tower could safely carry a counterweight of up to 200 pounds.

The cradle which supports the hinge consists principally of a pair of 4 × 4 uprights, spaced slightly more than the width of the tower. These are joined by 2 × 2 cross-members and held securely in place by angle-iron braces. To prevent

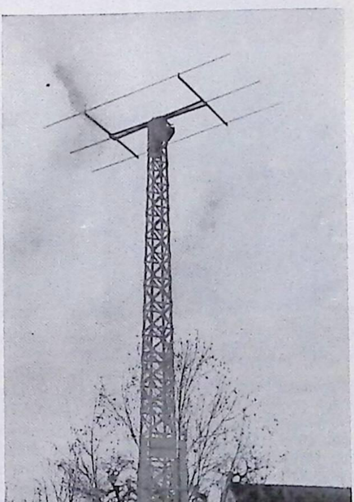


Fig. 6-9 — W6RWO's 40-foot tilting lattice tower with the 10-meter rotatable array in place.

rotting out at the base, the bottom ends of the 4 × 4s are not imbedded directly in the cement base but are supported about 4 inches above the ground on 3-foot lengths of angle iron set in the concrete. The lower ends of the angle-iron braces are fastened to heavy bolts embedded in the cement.

The hinge consists of a pair of iron pipes, one rotating within the other. The outer pipe is fastened to a panel on the tower, while the inner pipe, which serves as the axle, is supported in holes at the tops of the 4 × 4s.

When the cradle is ready, the base of the tower can be hoisted up into position with the top end lying on the ground. When the pipe on the tower is lined up with the holes in the tops of the 4 × 4s, the inner pipe can be slid through the holes and the outer pipe. The tower can then be swung up into a vertical position by pulling downward on a

Fig. 6-10 — Antenna adjustments are made easily at the ground. Raising and lowering the antenna and mast top section take but a few minutes.

rope attached to the base of the tower. The counterweight to be attached to the base of the tower can be chosen to suit any desired degree of unbalance, remembering that the weights at the ends to maintain balance are in inverse proportion to the lengths either side of the hinge. Thus, disregarding the weight of the mast itself, a pound added at the top end is compensated for by a counterweight of 1½ pounds at the base, when a 40-foot tower is hinged 16 feet up from the base. After the antenna has been mounted, different weights can be hung temporarily on the base to find the counterweight that makes raising and lowering easiest. The counterweights shown are made of cement and are bolted to the legs of the tower. When the mast is up, the bottoms of the legs are fastened to anchorages molded in the cement base.

While a fair amount of work is required to construct a tower of this type, the resulting arrangement is well worth while. To lower the tower it is necessary only to remove the four bolts at the base and push the lower end free of the anchorages so that it swings on the hinge. A 20-pound pull of the rope from the top brings the antenna down where you can work on it.

The tower measures 29 inches between legs at the base, tapering to 11 inches at the top. The four corners are made from 1 × 2 pine stock, laminated to make 2 × 2s. This makes it possible to keep the splices from occurring at the same height on all four corners. The various pieces are nailed together and glued with casein glue for additional strength and to keep the weather out. The cross-members are made of laths. The horizontal members are spaced every 21 inches with diagonal bracing in between. The cement base is 32 inches square and 30 inches deep with large bolts set 6 inches deep to hold the brackets for anchoring the mast and the cradle which provides additional support for the tower. Before mounting the tower, it should be given at least two coats of a good-grade house paint. The hinge arrangement makes it easy to repaint when this becomes necessary.

— *B. F. Davidson, W6RWO*

LOWERING AND RAISING A WINDMILL TOWER

There are old towers throughout some rural areas of the country that can be bought from farmers (if you are lucky!). Your problem then is: How shall I get it down and moved? It is fairly easy — if you know how. There are two ways to do it. The *hard* way is to climb to the top and remove the old windmill wheel and head and throw it down to the junkman. It's heavy, I warn you. And it is hard, dangerous work. Next get a cold chisel and proceed to cut off all the old rusted bolts, and take the thing down piece by piece. *One* tower is all you will wish to take down by this method. The *easy* way is to bolt a ten- or twelve-foot piece of 2 × 6 timber across the base of the tower, as shown in Fig. 6-11, place bracing 2 × 4s between the legs as illustrated, fasten the block and tackle to the tower, run the line over to the gin pole or tree, disconnect the legs, and lower the whole thing in one piece. Use rope guys to steady the tower during the process. You will be surprised how easily the tower comes down. The 2 × 6 prevents slipping at the base and adds a safety factor. Don't forget to dig up the anchor posts. Once on the ground you can use a cold chisel to cut off the bolts. Thoroughly buff off all rusty surfaces and apply a good coat of aluminum paint *before* reassembling. Be sure to use new galvanized bolts. It is well also to add a drop of "No-oxide" to the threads, in case the tower is taken apart again later.

You now have the tower disassembled on the ground and hauled home in your neighbor's borrowed car trailer. The corner-post sections will not exceed 22 feet in length, and may be only 11 feet long. In any case, you can haul them. The total weight of a 30-foot tower will be about 500 pounds, 600 pounds for a 40-footer and about 1200 pounds for one 60 feet high. Strangely

enough, it's much easier to erect them than it is to take them down. Again, there are two ways to do the job. First dig the holes and set the anchor posts. If the tower is being raised after assembly, leave the posts loose in the holes and tamp in dirt after the tower is up and leveled.

In assembling, start at the top and bolt the four side posts to the cast-iron cap. Note that the angle irons fit *inside* the cap. There is a hole through this cap approximately 4 inches in diameter that is handy for passing feed lines and cables. On a windmill, the pump rod works through this hole. The cap will usually have ample flange space for bolting on your mounting plate for attaching the beam head. At this point it is well to have considered your method of mounting of the rotary head, because it is much easier to drill holes on the ground. Once the first four corner-post sections are bolted on, it is as easy as playing with your son's Meccano set. Simply bolt on the cross-channel irons and place the diagonal cross-wire braces over the bolts as you work toward the bottom. Now and then you see a tower with strap-iron diagonal braces. Many towers use preformed heavy twisted galvanized wires, with eyes in the ends to fit over the bolts. These tighten and adjust more easily than strap iron. With the tower completely assembled on the ground, block up the end a few feet and attach your rotary mechanism. This is the way a windmill is raised. Bolt your 2 × 6 on the underside of the legs lying on the ground, as in Fig. 6-11, placing the bottom of the legs in line with the anchor posts. Level the legs with blocks if the ground slopes. Brace between the bottom of the legs with 2 × 4s if the tower has no girts at ground level. Attach your block and tackle, and up you go! But stop after the head is far enough off the ground to permit attachment of the boom and elements. Get it all over with one operation. This is much easier than dragging them up after the tower is in the air, even if you have taken our advice and rigged up a tilting head on top. Pull the tower on up, take it a little past center, fasten the two legs on the side near the gin pole, then ease it back and bolt on the other two legs. It is as easy as that. Then knock off for coffee and sandwiches for the gang! It took just 20 minutes to put up our last tower after all preparations had been made ready.

Your final job before tamping in the earth around the anchor posts is to level the tower accurately. If you desire a catwalk to work on, bolt two 1½ × 1½ × 8-foot angle irons alongside the top girt and parallel to the ladder. Across these you can bolt 2 × 8 × 18-inch planks. Then bolt four 1-inch angle irons from a point below the top of tower to the midpoint of the platform irons to serve as diagonal supports. It is more convenient to do this on the ground. We guarantee that you will have no fear of high places with such an arrangement.

Lack of space may prevent erecting a tower in one section. In that case first set the anchor posts and level them. Then build up from the ground, piece by piece. Many prefer this method. Where the corner posts are in short sections of 11 or 12 feet this is a simple procedure and can be done by one man working alone. With a partner on the ground to pass up the pieces, you can make fast

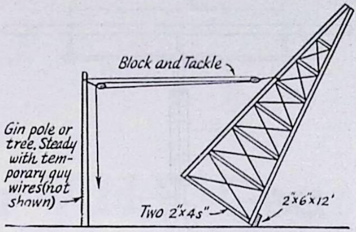


Fig. 6-11 — Suggested method for raising or lowering a steel windmill tower. The temporary 2″ × 6″ × 12′ timber bolted to the base serves to steady the tower, and the two lengths of 2 × 4 prevent any possible buckling of the base. Temporary rope guys on either side of the tower should be used to steady the structure while it is going up or coming down. After raising the tower, the two legs nearest the gin pole should be anchored first, after which the tower can be eased back and the other two legs fastened.

time. The ladder portion goes up in sections, too. If the splices are located *above* the points where the cross girts bolt on, you can lay strong planks across the girt frames to work on as you go up.

When you are finished, you will be proud of your job. In closing let us reply to the often-asked question, "Does the grounded frame of the steel tower affect the signal?" The answer is "No!" Some of the best signals on the air today come from amateur stations using steel-tower-supported beams.

— *Malcolm B. Magers, WØOJI*

BALANCED FEED LINE WITH COAXIAL CABLE

THE system shown in Fig. 6-12 has been used at this station to obtain a balanced line while still retaining the advantages of coaxial cable in shielding the feeder from pick-up. Two lengths of 52-ohm cable are used, with the shield braids soldered together at the top and the bottom of the line and grounded to the transmitter and to the electrical center of the driven element. The resulting line impedance is about 104 ohms. This can be matched to the driven element of almost any beam antenna by the simple "T" match as shown.

In my particular case, the reflector and driven elements are each 16 feet 5 inches, and the director is 15 feet 2 inches. Spacing between elements is 0.2 wavelength. The "T" bar is located 3½ inches below the driven element, and connection from the "T" to the driven element is made 10 inches each side of center.

No detuning is noticed when this line is run in close proximity to the beam elements, and it is unaffected by weather conditions. Pick-up (of man-made QRN) is reduced several decibels,

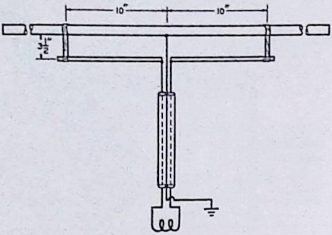


Fig. 6-12 — A balanced feed line using coaxial cable. Two lengths are used, series-connected as shown. A "T" is then used to effect the required match to the driven element of the beam.

and the line may be located at any convenient place.

— *William W. Bailey, W9AO*

HARMONIC REDUCTION WITH STUBS

Hams who are having trouble with harmonic radiation sometimes can make a substantial reduction in the amplitude of even-harmonic radiation by connecting the open end of a shorted quarter-wave stub to the antenna feeders or transmission line.

The function of such a stub is to present a short-circuit to all even-multiple harmonics of the transmitted frequency, while presenting a high impedance to the fundamental. Thus the stub causes no detuning or power loss, but eliminates the even-multiple harmonics.

The stub may be connected at any point along tuned or untuned transmission lines of either the parallel-wire or the coaxial type. A "T" connector will be necessary for tapping into coaxial lines.

If the transmission line is being used for more than one frequency band, the stub line may be made long enough for the lowest-frequency band used, and a shorting bar may be used to set the stub length to the proper position for each band. Continuous protection from lightning and static charges may be obtained by grounding the shorted end of the stub, and it will not be necessary to remove this ground during operation.

— *Roger T. Wilson, W3JHW*

USING LAMP BULBS AS DUMMY ANTENNAS

The commonplace lamp bulb is a handy gadget for measuring transmitter power output or for terminating a "flat" line during checking for harmonic radiation from the transmitter proper. The approximate resistances of common lamp sizes, at full brilliance, are as follows:

25-watt.....600 ohms	100-watt....150 ohms
40-watt.....350 ohms	150-watt....100 ohms
60-watt.....250 ohms	300-watt.... 50 ohms

Use a combination of lamps that will match the transmitter power output as closely as possible. For example, if the output is 200 watts into 75-ohm line, use two 100-watt lamps in parallel; for 400 watts into 600-ohm line, use four 100-watt lamps in series, etc.

A COMPACT VERTICAL FOR 75 METERS

A vertical antenna system that has been used on 75 with good results and that is only 17 feet high is shown in Fig. 6-13. It is a version of the folded dipole, with each conductor loaded. The top of each conductor is a 12-foot length of aluminum tubing mounted at the end of a 5-foot 1¼-inch diameter ash pole. A coil of 30 turns of No. 11 d.c.c. wire is wound on the wooden pole below the end of the aluminum tubing, one lead

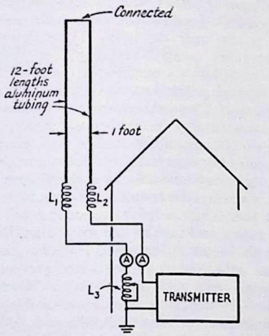


Fig. 6-13 — This small antenna has worked well at W5TG. The inductance L_3 is adjusted for equal current in the two lines. L_1 and L_2 are each 30 turns of No. 11 d.c.c. on 1¼-inch diameter wooden supports for the aluminum tubes.

from the coil going to the tubing and the other running in feed-through insulators into the shack and down the wall to the transmitter. The pole and coil are sprayed with Glyptal to protect them from the weather, and the two poles are mounted a foot apart on the side of a metal Quonset hut, with only the tubing extending above the roof.

The loading coil at the ground connection is used to tune the system. It is varied until the currents in the two conductors are equal. When the currents in the two lines are matched, the system takes power nicely and the received signals come up. The results obtained with this antenna compare favorably with those from a much larger system, and many good reports have been received with only 75 watts to the transmitter.

— *James W. Hunt, W5TG*

7. Hints and Kinks . . . for V.H.F. Gear

ONE-TUBE V.H.F. RECEIVER

Here is a one-tube v.h.f. receiver that worked very well for me, and I thought some of the boys might like to make up a simple job that has lots of sock, even though it has but one tube. Fig. 7-1 shows the details of the circuit. For 144 Mc.

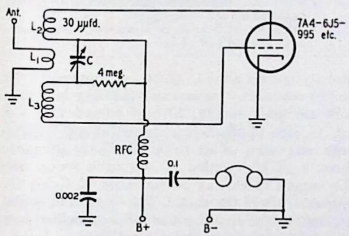


Fig. 7-1 — A one-tube v.h.f. receiver. The values of the components are shown in the diagram, except for L_1, L_2 and L_3, for which the suggested values are 2, 4 and 4 turns respectively, for the 144-Mc. band. The usual "cut-and-try" method should result in maximum performance on this receiver.

I suggest four turns ½ inch in diameter, No. 14 wire, for the plate and the grid coils. Experiments will show the exact number of turns and spacing required to cover the band in a particular receiver.

— *John J. Kaiser*

IMPROVED 144-MC. RECEPTION

Owners of the SCR-522 can make a substantial improvement in receiver performance by the use of the regular station communications receiver in the same manner that the "Q5-er" is used on the lower-frequency bands.

The communications receiver is used as an additional i.f. amplifier and audio channel. It is loosely coupled to the last i.f. transformer of the 522 by twisting a wire once or twice around the lead that runs from the last i.f. transformer of the 522 to the 12C8 detector tube. The other end of the wire is connected to the antenna post of the communications receiver. The communications set is then tuned to about 12 Mc., the i.f. frequency of the 522.

Rough tuning is accomplished with the dials of the 522 in the usual manner. Then the bandspread dial of the communications receiver is used for peak reception.

This system of reception offers all the conveniences of low-frequency operation: stable easy-to-read signals, bandspread tuning, S-meter, b.f.o., noise-limiter action, and a better audio system. Most important, however, is the improvement in signal-to-noise ratio obtained because of the narrower passband of the system. Unstable or badly-drifting signals can be received as usual on the 522 alone by turning the audio gain of the 522 up, while reducing it on the low-frequency set.

— *Francis H. Stites, W1MUX*

ALIGNMENT AID FOR V.H.F.

A simple, effective alignment indicator for receivers using superregenerative second detectors, such as those described in *QST*, consists of a 0–100 microamp. meter in series with a 0.1-megohm resistor, connected as shown in Fig. 7-2.

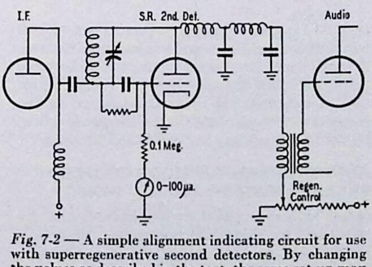


Fig. 7-2 — A simple alignment indicating circuit for use with superregenerative second detectors. By changing the values as described in the text, the same set-up may be used for field-strength measurements.

Using this set-up, and with the regeneration control turned fully off, the detector tube acts as a diode rectifier. It is not necessary to by-pass the plate to ground, because at the frequencies where these detectors are usually operated (10 Mc. or higher) the stray circuit-and-tube capacitance is usually sufficient.

With this device, and very loose coupling of the mixer grid to a signal generator, a reading of 50 to 100 microamperes is easily obtained. The i.f. and mixer stages can then be trimmed to obtain top performance.

If desired, the circuit may be used for field-strength measurements by increasing its sensitivity. In this use, the resistor should be 0.5 megohm and the meter 0-30 microamperes.

— *Erich Kohout, HB9AT*

A TWO-BIT TWO-MINUTE 420-MC. GROUND-PLANE

W7KWO, one of the more active 420-Mc. operators in the region around Phoenix, Arizona, says that a ground-plane is unquestionably *not* the world's best antenna for 420 Mc., but it can be the quickest and possibly the cheapest, if made as shown in the photograph of Fig. 7-3. Tom takes an Amphenol coaxial fitting,

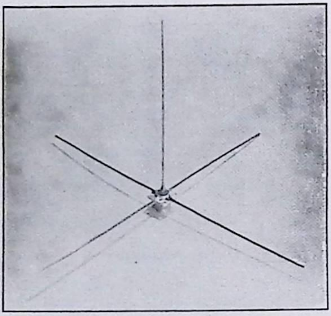


Fig. 7-3 — A new low in antenna complexity is this 420-Mc. ground-plane suggested by W7KWO. It consists of a Type 83-1R coaxial fitting and five 6½-inch pieces of stiff wire.

type 83-1R, and solders a 6½-inch piece of stiff wire (No. 12 will do, or welding rod may be used, if handy) into the center conductor. Four more pieces are soldered to the flange of the fitting for the ground-plane. If these are soldered in the position shown, the holes in the flange are left to be used for mounting the completed antenna.

ADAPTING THE CATHODE-COUPLED PREAMPLIFIER TO 144-MC. WORK

The cathode-coupled preamplifier circuit described by W1DX in September, 1947, *QST* can be used on 144 Mc. with good results with only slight modification. The original circuit is retained, but the values of a few components, and the coils, are changed. The circuit is shown in Fig. 7-4.

The amplifier was built on a small aluminum chassis with a copper shield extending across the center of the tube socket. Pins 4 and 6 and the center extension of the socket are grounded

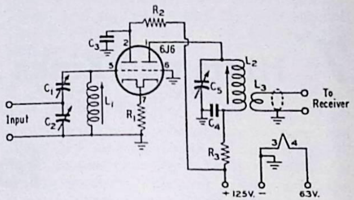


Fig. 7-4 — Circuit diagram of the cathode-coupled preamplifier adapted for use in the 144-Mc. band.
C_1 — 3-30-μμfd. mica trimmer (National M-30).
C_2 — 75-μμfd. midget variable.
C_3 — 680-μμfd. ceramic.
C_4 — 100-μμfd. ceramic.
C_5 — 20-μμfd. midget variable.
R_1 — 470-ohm ½-watt carbon.
R_2, R_3 — 1500-ohm ½-watt carbon.
L_1 — 3½ turns No. 20, ¼-in. inside diam., with 1/16 inch between turns.
L_2 — 4 turns No. 20, ¼-inch inside diam., with 1/16 inch between turns.
L_3 — 3 turns No. 18 flexible hook-up wire, close-wound over ground end of L_2.

directly to this shield, which is mounted on the socket screws by means of soldering lugs. The coils are made of No. 20 bare tinned wire, and are ¼ inch in diameter, spaced about 1/16 inch between turns. The rotor of C_5 is grounded directly at the center of the tube socket and the copper shield, as is the rotor of C_2 on the opposite side of the shield. The input and output portions of the circuit are carefully shielded from one another to prevent self-oscillation.

This circuit was used ahead of an SCR-522 receiver with excellent results. Signals that were audible but unreadable without the amplifier became R5. Although the noise comes up somewhat with the signal, there is a definite improvement in signal-to-noise ratio and the over-all gain is equivalent to about three S-points. The input from the antenna in the case described is 300-ohm Twin-Lead, and the output to the 522 is a short length of 72-ohm coaxial cable. The entire unit can be enclosed in a small cabinet with its power supply, and is a worth-while addition to any receiver.

— *Roy R. Maxson, W6DEY*

FIELD-STRENGTH INDICATOR FOR 420 MC.

Ever try to get a radiation pattern of your 420-Mc. array? If you have, you know that reflections from surrounding objects can be mighty confusing. A person walking several wavelengths in back of the field-strength meter, for instance, will cause readings to vary widely. To get around this difficulty, W3GKP, Silver Spring

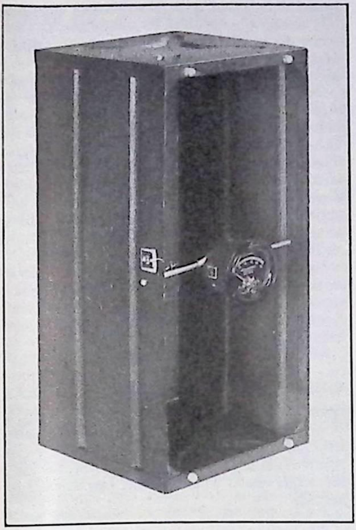


Fig. 7-5 — **A field-strength indicator for 420 Mc. made from the case of a BC-375 tuning unit, a microammeter, a 1N34 crystal, and two pieces of copper tubing. This model was assembled in the Headquarters lab at the suggestion of W3GKP, who uses a similar arrangement to eliminate reflections from objects in back of the meter.**

Maryland, uses one of the CS-48 storage cases from the tuning units of the BC-375 transmitter as a slot or cavity antenna for his field-strength meter.

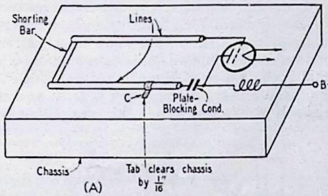
To check the idea a similar unit was built in the Headquarters lab, and a photograph is reproduced in Fig. 7-5. As may be seen, a microammeter is mounted at the center of the box opening, in series with a crystal diode and two short lengths of tubing. Copper tubing $\frac{3}{16}$ inch in diameter is used, as this can be readily tapped with a 6-32 thread. One section of tubing has a loop of No. 16 wire soldered to it to form a lug fitting over the meter terminal. The other piece is soldered to a 1N34 diode, the other end of which connects to the other meter terminal. The two pieces are just long enough to fit inside the box and are fastened in place with short 6-32 screws through the sides of the box.

Polarization is parallel to the wire; that is, with the unit in the position shown, polarization is horizontal. The main lobe is in front of the open side of the box. The arrangement has a useful gain over a dipole antenna, in addition to reducing trouble experienced from reflections. The only disadvantage Smitty can think of is that, with the box having a cut-off frequency of about 300 to 350 Mc., the gadget is good only for 420 Mc. and higher. He suggests that some reader put him in touch with a reputable grave robber, who would dig him up a 144-Mc. job!

TWO V.H.F. ADJUSTMENT HINTS

THE idea shown in Fig. 7-6A is useful in getting parallel-line oscillators to work. After building such an oscillator it is usually found that the r.f. voltage gradient along the two sides of the line is not symmetrical. This lack of symmetry is caused by the difference in tube and other stray capacitances to ground at the two hot ends of the line. A small tab, *C* (placed with the horizontal part clearing the chassis about a sixteenth of an inch), will balance the line and improve oscillator performance. This will also reduce the tendency toward "squegging."

Another important kink concerns the adjustment of the grid excitation in u.h.f. and v.h.f. oscillators. Condensers have been shown in equipment but their function is often overlooked. In the usual "grid-separation" circuit, the excitation is determined by the ratio of plate-cathode to grid-cathode capacitance. Normally the grid excitation is too large. This causes downward loading of the oscillator and the no-load plate current is too high.



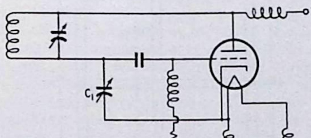


Fig. 7-6 — **Two v.h.f. equipment adjustment ideas. The small tab added to the plate line, as shown in A, helps restore symmetry and improves operation. The excitation control, C_1, shown in B, is often overlooked in u.h.f. and v.h.f. oscillators. Downward loading and abnormal plate current of the oscillator will be prevented if the grid-cathode r.f. voltage is reduced by proper adjustment of this condenser.**

Reducing the grid-cathode r.f. voltage by adding a 5–15-$\mu\mu$fd. condenser, C_1 in Fig. 7-6B, from grid to cathode, will reduce the no-load plate current and the grid current and will make the oscillator load upward as it should.

— *Lawrence Fleming*

A 2-METER BCI CURE

A very stubborn and acute case of 2-meter BCI was eliminated entirely by a simple yet effective method. Ninety per cent of the interfering signal was found to be entering the broadcast receiver (one of the midget variety) via the a.c. power line. The remaining ten per cent was found on the twenty-foot wire that was being used as an antenna.

Three r.f. chokes, each made of 45 turns of No. 17 enameled wire, ⅜ inch in diameter, were used. One was inserted in each side of the a.c. line, one at the power switch and one in series with the plate of the rectifier tube. These chokes were mounted under the chassis in the clear on stand-off insulators. The third choke was mounted directly on the antenna input terminal, and connected in series with the antenna.

Any form of insulation used to cover the chokes, such as friction tape or spaghetti tubing, will reduce their effectiveness.

— Clarence G. Jeffers, W1LZR

ROTARY BEAM ANTENNA FOR 2-METER WORK

The construction of the rotary beam antenna shown in Fig. 7-7 is a little unusual, but the results obtained with it have more than justified the trouble encountered in its construction. The beam is the design of Russ Patterson, W4CPG, who made numerous tests with it from various fixed and mobile locations in this area. Using the beam, signals that were S4 to S5 on a comparison "J" antenna came up to S9 and better. The beam seems to be about 30 degrees wide, and has a fairly high front-to-back ratio, although not so high that nothing can be heard off the back of it.

The elements and matching stub are constructed of ½-inch thin-wall tubing. The spacing between the stub and element *A* is two inches. Other dimensions are shown in the diagram. The supporting arm for the reflector and director is a single piece of tubing, which is soldered directly to the radiator. Thus soldered joints appear at all points marked *X*. The entire assembly was mounted on a rotatable support with ceramic stand-off insulators.

Results obtained at both fixed locations and in mobile conditions with the antenna mounted on a car have been equally good. The center frequency obtained with the dimensions shown is 145 Mc.

— J. Wayne Clark, W6CAN

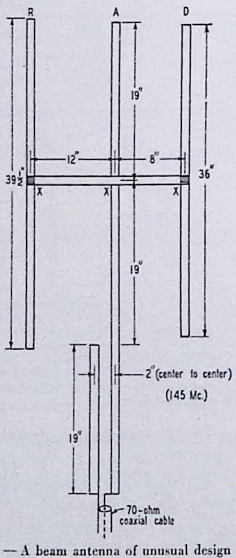


Fig. 7-7 — A beam antenna of unusual design for use in the 2-meter band.

V.H.F. MODULATOR WITH A2 AND A3

The single-tube modulator shown in Fig. 7-8 provides for both voice and tone modulation, with but a single tube. A neon bulb (with resistor removed) is used as a tone generator, for use on the v.h.f. bands where m.c.w. operation is permitted.

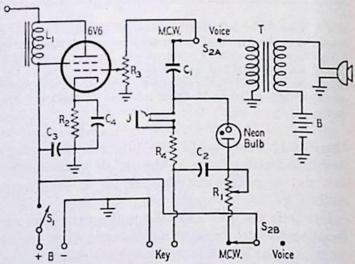


Fig. 7-8 — Single-tube v.h.f. modulator for m.c.w. or voice.

C_1, C_3 — 0.1-μfd. 400-volt paper.
C_2 — 0.2-μfd. paper.
C_4 — 10-μfd. 25-volt electrolytic.
R_1 — 0.25-megohm potentiometer.
R_2 — 470 ohms, 1 watt.
R_3 — 0.5-megohm potentiometer.
R_4 — 4700 ohms, 1 watt.
L_1 — Modulation choke, 30 hy.
B — 4½-volt microphone battery.
J — Monitor jack, closed-circuit type.
S_1 — S.p.s.t. switch.
$S_{2A, B}$ — D.p.d.t. switch.
T — Microphone transformer.

The potentiometer, R_1, serves as a pitch control. Some variation of R_4 and C_2 may also be necessary to get some neon bulbs to oscillate at the frequency desired. Insertion of headphones in the monitor jack permits adjustment of the modulation tone and provides a means of monitoring keying as well.

— Henry Morris

TAMING HY-75 CIRCUITS

In *QST* for March, 1945, mention was made in "Hints and Kinks" of steps to be taken in resoldering the top cap leads of the HY-75. The explanation of the need for resoldering took into account only the actual melting of the solder. It did not explain the underlying cause for its occurrence.

In an attempt to discover this reason, I have spent about 500 hours in experimenting with the HY-75 in various v.h.f. circuits. The results of these experiments show that the melting is not the result of heat generated by the tube elements during normal operation, but is caused by abnormally high r.f. currents, usually at a harmonic of the fundamental frequency, stemming from improper design of the oscillator circuit. These currents are high enough to cause considerable heat to be generated when flowing through even the small resistance presented by the soldered connection.

Fig. 7-9 shows the current distribution *at the second harmonic* on a quarter-wave tank circuit under various conditions of added inductance and capacitance. The portion of the line shown between the condenser and the shorted end of the line could be replaced by a coil and the analysis would still hold. The curves illustrate that as the line is shortened, the current maximum moves closer to the soldered connection at the tube caps. Under certain conditions it can be right at the caps, and if the tuning capacitance is at the same time large enough to offer a very low reactance at the second harmonic (or at a parasitic frequency) the amplitude of the current flowing at the caps may be great enough to cause the solder to melt.

In the commonly-used coil-and-condenser circuit, one other source of trouble may be present. If the tuned circuit is so adjusted that the portion of the coil between the condenser and the plate-supply lead can act as an r.f. choke at the undesired frequency, the condenser may then look like a short-circuit across the end of a line made up of the tube-lead inductance plus the lead to the tuning condenser, and abnormal heating will result.

The cure for these troubles will vary with different circuits, but some generalizations can be made. The use of filament chokes (27 turns of No. 18 close-wound on a ⅜-inch form) eliminates the trouble in HY-75 oscillators in the 2-meter band. Possibly the tuned-choke system shown on page 29 of *QST* for April, 1946, might work as well, but this was not tried.

The *L/C* ratio of the tuned circuit can often be altered to shift the current loop. The tuning condenser can be completely eliminated and the frequency adjusted by varying the *L* to resonate with the tube capacitances at the desired frequency. Tuning a quarter-wave line with a relatively large condenser replacing the usual shorting bar also provides proper operation. The most straightforward method is to use a shorting bar for tuning, with a high-quality blocking condenser of about 500 μμfd. The condenser must have low lead and internal inductance.

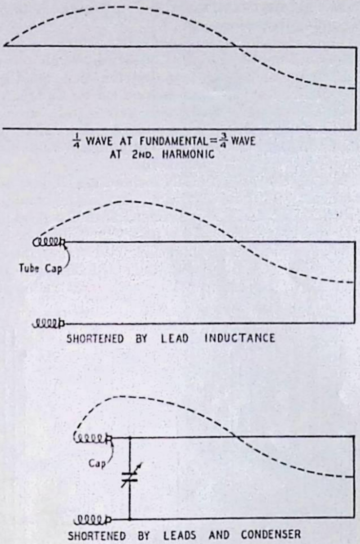


Fig. 7-9 — Current distribution at the second harmonic along a "quarter-wave" line. If peak current occurs at or near the tube cap, as shown in the bottom sketch, overheating and consequent melting of the solder can occur.

With the HY-75 operating in a properly-designed circuit the solder at the tube cap will not melt. Any softening of the solder is a sure warning that something is wrong with the circuit, with either harmonic trouble or a parasitic oscillation being the usual cause. Other changes may be necessary in particular circuits, but the suggestions given above should clean up the difficulty in most cases. Although these tests were made only with the HY-75, it is possible that similar conditions may exist in v.h.f. circuits using other tubes.

— *George D. Perkins*

A BROAD-BAND ANTENNA FOR 50 MC.

Because he wanted to operate in the high half of the band, and still be able to do a creditable job of receiving at the low end, W1EYM, Fairfield, Conn., developed the array shown in Fig. 7-10. It consists of four similar folded dipoles, each cut for the center of the band (108 inches long) except for the reflector unit which has 4-inch extensions at each end. The dipoles are mounted a quarter wavelength apart, and fed as shown in the drawing. Though work with the antenna system is still in the experimental phase,

W1EYM has established the following facts regarding its performance:

1) It provides a reasonably flat match to a 470-ohm line over the entire 50–54 Mc. band.

2) It has an average gain over the whole band of 8 db. over a half-wave antenna cut for 52 Mc.

3) The front-to-back ratio varies from approximately 3 db. at the low end to about 12 to 15 db. at the high end, this fairly high front-to-back continuing on up to 60 Mc.

The dipoles are each 108 inches long. If they were cut for the low-frequency end of the band (about 110 inches) it is believed that the good front-to-back ratio would extend throughout the band. As climbing up and down the tower for each adjustment became quite an arduous proposition, Nat has been working with scale models

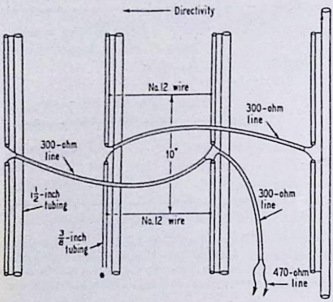


Fig. 7-10 — Detail drawing of the broad-band 50-Mc. antenna system worked out by W1EYM. Four folded dipoles, 54 inches apart, are driven as shown, the impedance at the feed-point being approximately 470 ohms. The dipoles are 108 inches long, except for the reflector element, which has 4-inch extensions at each end. Interconnecting sections of 300-ohm line are approximately 108 inches long. The section of 300-ohm line inserted between the 470-ohm transmission line and the second dipole is a half-wave long (minus propagation-factor shortening) and is used to provide a flexible section rather than for matching purposes. The sections of each dipole are 2.94 inches apart, center to center. Performance characteristics are given in the text.

on 420 Mc. Reflections have been bothering him in making accurate measurements on this frequency, and the project is being held up until tests can be conducted in an open field which will be devoid of the reflection problems.

THE "TINY TIM" 144-MC. HANDIE-TALKIE

The article on the "handie-talkie" in June, 1944, *QST*[1] brought comments and inquiries from all over the United States, Canada and South America. But the prize came from quite close to home — from a friend who, on seeing the article, observed "Why didn't you build a *small* one?" A challenge like that couldn't be ignored, naturally, and the result of it all is the new version shown in the photographs.

This "Tiny Tim" handie-talkie has been in operation for some time, first in WERS work, then on the 112-Mc. band after the reopening, and still later on the 144-Mc. band. It is 7⅛ inches high, 2⅝ inches wide, and 1⅛ inches thick, and weighs only 1½ pounds complete with batteries. Since it is small enough and light enough to slip into a coat pocket it can be carried and used on a second's notice. Good reports have been received at distances up to two miles, although its primary purpose is for communication with mobile or fixed stations which ordinarily would be within a few city blocks of the portable unit.

Two tubes are used in a transceiver circuit, a 957 as the detector and oscillator and a second 957 as the audio amplifier and modulator. If somewhat more power is desired it would be possible to substitute 958s for the 957s. The battery power supply, contained in the same case, consists of a single No. 1 flashlight cell and one midget 45-volt "B" battery (Burgess XX30). The drain on the flashlight cell is 100 milliamperes and the "B" current is only 3 milliamperes.

As shown in the circuit diagram, Fig. 7-12, a three-pole two-position switch, S_1, is used to change over from send to receive. One switch section connects or disconnects the microphone, the second section connects the proper grid leak, and the third section shifts the oscillator plate circuit from the primary of the transceiver transformer, T_1, to which it is connected for receiving, to the plate of the audio amplifier-modulator for transmitting. The headphone is made to do double duty by serving as a modulation choke during transmission.

The case is made from two pieces of aluminum.

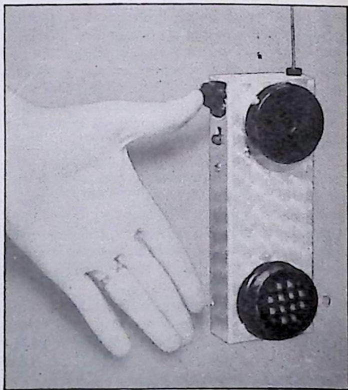


Fig. 7-11 — A handie-talkie that is really handy — its approximate dimensions are 7 by 2½ by 1 inches. Completely self-contained and small enough to be slipped into a pocket, it has a range of a mile or more in reasonably open terrain.

[1] Haist, "A Self-Contained Handie-Talkie," *QST*, June, 1944.

One, on which the parts are mounted, is in the form of a U-shaped channel as shown in the inside view. The other is bent at the top and bottom to complete the enclosure. The microphone is a single-button unit (Universal type W) mounted on a circular block cut at an angle so that it is properly tilted for voice pick-up when the headphone is held against the ear. The headphone is one unit of a 2000-ohm set mounted to the case by two screws.

The tubes are mounted by soldering the two negative filament pins (Nos. 4 and 5) to small brass angles which in turn are mounted on opposite sides of the case as shown in the inside view. The screws that hold the angles to the case also are used to mount the two switches, S_1 and S_2. S_1 is mounted underneath the tuning knob while S_2 is on the opposite side.

The tuning condenser is a revamped 3 – 30-μμfd. trimmer. The adjusting screw was removed and its head was cut off, then the screw was threaded tightly into a ¾-inch length of ¼-inch diameter round polystyrene rod. The assembly was then rethreaded into the condenser so that the end of the poly rod pressed against the movable plate, thereby providing a miniature tuning condenser with the shaft extending outside the case for ready adjustment. The tuning knob is equipped with stops so that it can be rotated just sufficiently to cover the 144–148-Mc. band. The condenser and tank coil, L_1, are supported by

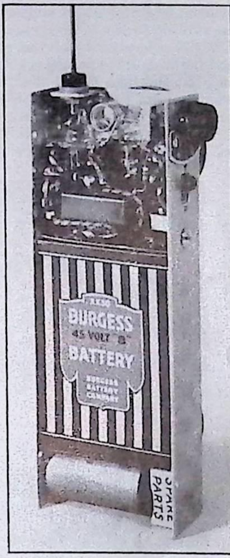


Fig 7-13 — Inside the handie-talkie. Over half the case is occupied by the battery power supply. To save space no tube sockets are used, the connections being soldered directly to the tube pins.

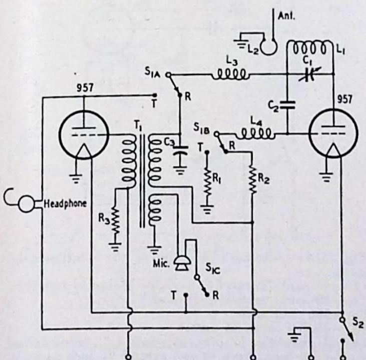


Fig. 7-12 — Circuit diagram of the 144-Mc. handie-talkie.
C_1 — 3-30-μμfd. ceramic trimmer (see text).
C_2 — 50-μμfd. ceramic fixed.
C_3 — 0.002-μfd. 200-volt midget paper.
R_1 — 22,000 ohms, ¼ watt.
R_2 — 10 megohms, ¼ watt.
R_3 — 390 ohms, ¼ watt.
L_1 — 5 turns No. 16, ⅜-inch inside diameter, length ⅜ inch.
L_2 — 1 turn No. 16, ⅜-inch inside diameter.
L_3, L_4 — 50 turns No. 36 d.s.c. on 10-megohm ½-watt resistor.
$S_{1A, B, C}$ — Triple-pole double-throw slide switch.
S_2 — Single-pole single-throw slide switch.
T_1 — Transceiver transformer (Inca I-45)

their leads, one end of the tank circuit being soldered to the plate lead of the tube.

The antenna plugs into a pin jack mounted on an aluminum angle which is bolted to the case at the top. Steel or brass rod 1/16 inch in diameter may be used for the antenna; a length of approximately 18 inches is required for a quarter wavelength. The length may be pruned to the optimum figure by starting with the rod a little long and cutting off a bit at a time until the antenna shows the maximum tendency to throw the superregenerative detector out of oscillation when set in the 144-Mc. band.

— *Charles T. Haist, jr., W6TWL*

PUSH-PULL 826 AMPLIFIER FOR 144 MC.

Two-meter men who want to put in fairly high power are overlooking a good bet in the 826 tubes, now available at ridiculously low prices on the surplus market, according to W2GPO. Puss is running *600 watts* to a pair of 826s, in the amplifier shown in Fig. 7-14. The layout is unconventional, but effective. The tube sockets are mounted on edge, by means of hook bolts made from ordinary machine screws, and are maintained in alignment by stiff rods connecting the filament terminals. The grid circuit is a tuned loop of wire, and the plate tank is ¾-inch silver-plated copper, bent into a semicircular shape. This is also condenser-tuned, so that the position of the shorting bar is not changed in the course of ordinary adjustments. Neutralizing

condensers are pieces of aluminum mounted in the two top socket holes on each side.

Initial experiments with this amplifier showed that far beyond the normal tube ratings could be run, but the tank circuit ran very hot. Larger tubing, plus a blast of air from a small electric fan, took care of this. Plate current is 400 ma., at 1600 volts. The driver is an ARC-5, with 400 volts on the 832-A. This provides 40 ma. grid

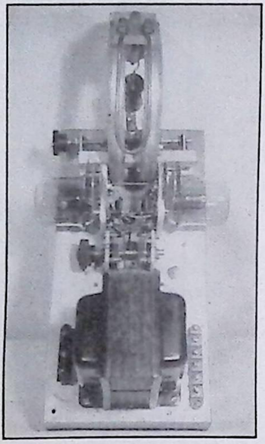


Fig. 7-14 — With this amplifier of unusual design, W2GPO is able to run 600 watts input on 144 Mc. Final tubes are 826s, mounted in a horizontal position. An electric fan is turned on the tubes and tank circuit for forced-air cooling. See text for further details.

current, at 140 volts bias, in the 826s. Grid resistor is 3500 ohms.

A GRID-DIP METER FOR V.H.F.

If you do much construction work in the v.h.f. range, you will appreciate the need for a sensitive grid-dip meter to check the resonant frequency of an unknown tuned circuit. It must be small enough to couple into some of the rather minute tuned circuits that are used. To fill such a need in the Headquarters lab, the gadget shown in Fig. 7-15 was built. It is patterned after the one described in March, 1948, *QST* by W2BFD.

An acorn triode in an ultraudion circuit is mounted at the end of a thin "paddle" made from scrap Masonite. The coil of the oscillator circuit extends beyond the end of the paddle, to permit its insertion into the field of the coil of the circuit being worked on. A "push-to-operate" switch is mounted at the handle end of the paddle, so that the power, which is obtained from small external dry cells, is turned on only when a measurement is to be made. The meter, which can be a 0–1 d.c. milliampere movement, is external to the unit and is connected in the d.c.

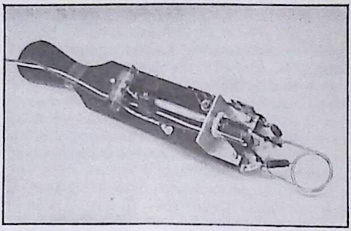


Fig. 7-15 — A handy probe-type grid-dip meter for the v.h.f. man. The tuned circuit and the acorn tube are mounted at one end of the "paddle."

grid return through wires that are taped to the handle. The circuit is shown in Fig. 7-16.

A small paper scale is pasted to the front of the bracket that supports the tuning condenser, and an approximate frequency calibration is inked in.

To use the gadget to check the resonant frequency of a tuned circuit, hold it with its coil near the circuit in question and tune the dial. At the point of resonance, the grid current indicated will dip sharply.

The unit can also be used to detect the presence of v.h.f. parasitics in low-frequency gear by

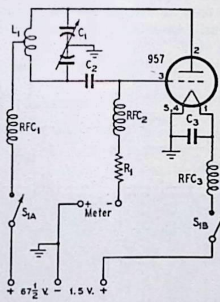


Fig. 7-16 — Schematic diagram of the v.h.f. grid-dip meter.

C_1 — 11-$\mu\mu$fd. "butterfly" variable (Johnson 160-211).
C_2 — 50-$\mu\mu$fd. ceramic (National XLA-0).
C_3 — 680-$\mu\mu$fd. mica.
R_1 — 68,000 ohms, ½ watt.
L_1 — 2 turns No. 12 wire, 1 1/16-inch i.d., turns spaced 1/32 inch. Ends of coil extend 5/8 inch past o.d. of coil.
RFC_1, RFC_2, RFC_3 — 1-μhy. r.f. choke (National R33).
S_{1A-B} — D.p.s.t. "push-button" type toggle switch, normally open.

similar methods. Hold it with its coil near a tuned circuit in which a parasitic is suspected and tune through the condenser range. A sharp kick in grid current will be indicated when the unit is tuned to the spurious frequency.

With the layout and coil dimensions shown, this unit tuned the range between 128 and 160 megacycles.

— *C. Vernon Chambers, W1JEQ*

8. Hints and Kinks . . .

for Keying and Monitoring

AUTOMATIC BREAK-IN CIRCUIT

WITH THE automatic break-in circuit shown in Fig. 8-1, the transmitter is turned on with the first dot or dash, and is automatically turned off a predetermined interval (usually one-third to one second) after the operator stops keying. Between "on" and "off," the rig may be keyed as usual, provided that at no time is there an interval between keying characters of more than the length of time required for the automatic "off" action to take place. Thus the need for a stand-by switch is eliminated, permitting fast, efficient operation with the key as the only operating control.

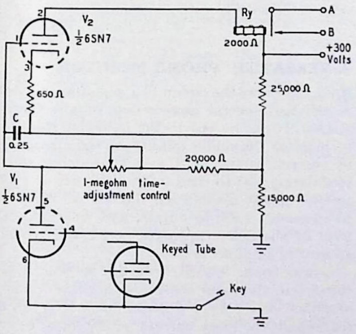


Fig. 8-1 — **An automatic break-in circuit with adjustable time delay.**

The circuit has two divisions, V_1, which fully charges condenser C each time the key is closed, and V_2, which has a s.p.s.t. relay (contacts normally closed) for switching the whole rig on and off in its plate circuit, and a time-delay circuit in its grid return.

Under "key up" conditions, V_1 is cut off, as its cathode circuit is open, and V_2 is conducting, holding contacts A and B of the sensitive relay open. When the key is closed for the first time, V_1 conducts, and its plate current, flowing through the potentiometer, increases the bias on V_2 beyond cut-off, causing the relay to close the circuit between A and B. The condenser C, in the meantime, has charged fully, acting as a holding bias to keep V_2 cut off. When the key is next opened, C starts to discharge through the potentiometer, but because the time constant of the circuit is long, it cannot discharge fast enough to permit V_2 to become conductive before the next keyed character comes along to charge it up again. Thus, the circuit between A and B remains closed so long as dots and dashes are coming along at the usual keying rate. Once the key is left open long enough for C to discharge, however, the circuit opens, taking the transmitter off the air. The time delay used may be adjusted to suit the operator's individual keying speed by means of the potentiometer.

The relay may be used to close the circuits of a number of other relays, thus permitting complete station control from the key. If the delay obtained is too long or too short, try replacing the condenser C with another of the same value. Sometimes the actual capacitance may not be that shown on the label, and in one instance I found one, with the correct label and size, that gave a delay of fourteen seconds, while most condensers tried gave a two- or three-second delay at the maximum.

I suggest that the transmitter power-supply circuit be examined to insure that the automatic break-in circuit cannot turn off the same power supply that furnishes its plate voltage! If desired, a switch may be connected across the relay contacts to disable the automatic break-in circuit when you are asked to QRS when the delay circuit has been adjusted for fast keying.

— *Henry L. Cox, jr.*

QUIET BREAK-IN OPERATION

IN THE November, 1945, *QST* Clayton C. Gordon, W1HRC, asked for a way to eliminate

the annoying racket in the receiver when working break-in on spot-frequency nets. There are undoubtedly many others who have wrestled with the same problem who may be interested in the system shown in detail in the schematic diagram of Fig. 8-2. This was in use at W8BLO in the period prior to the war, working out very nicely in AARS work.

An auxiliary gain control, R_1, is inserted at the ground end of the normal receiver r.f. gain control, R_2. Relay Ry_2 is connected across R_1, shorting it out when the key is up. This relay and Ry_1 (the keying relay) operate from the same source of power. The normal receiver gain control, R_2, is adjusted for satisfactory reception of incoming signals; then, with the key down and the transmitter running, R_1 is adjusted for the desired level of reception of the signal from the transmitter. This system does not produce the loud clicks which result when the receiver is switched off entirely when the key is pressed, and in addition it gives one a continuous monitoring of his own signal. To protect the receiver, in case it is desired to use the transmitting antenna for receiving, an additional relay should be used to remove the antenna from the receiver when the key is pressed.

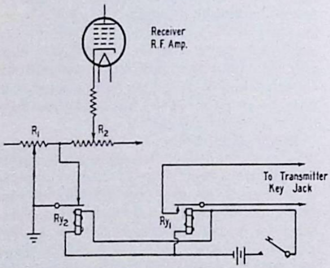


Fig. 8-2 — A system for obtaining quiet operation when working break-in on spot-frequency nets. Ry_2 is similar to Ry_1 except that it is normally closed.

Another idea I found useful in conjunction with this system was to feed the output of my monitor into the grid of the first audio tube of my receiver, enabling me to monitor my transmissions while working someone not on my own frequency.

— *Elwyn Guest*

A GADGETLESS BREAK-IN SYSTEM

Shown in Fig. 8-3 is a smooth-working break-in system that requires only a short length of wire and a s.p.d.t. toggle switch, plus a few minutes to hook it up. In operation it provides all the features of more complex systems, and makes working BK a pleasure. It is adaptable to any rig that contains an unkeyed self-biased stage.

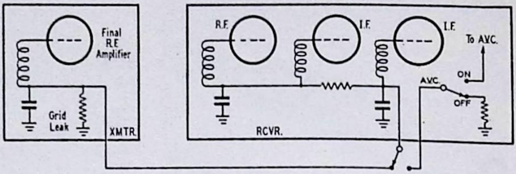


Fig. 8-3 — Simplified schematic diagram of a gadgetless break-in system that is adaptable to many rigs with almost no effort.

A wire is run from the bias end of the grid leak to the a.v.c. line in the receiver. Thus, when excitation is present, the bias voltage developed across the grid leak is applied to the a.v.c.-controlled tubes in the receiver, reducing their gain to the point where the signal from your own rig comes out about S4. Should the other station wish to break you, he merely sends BK a couple of times, and you hear him at his normal signal strength because the receiver returns to full sensitivity between keyed characters.

At W3HLK, this system has been used successfully with a BC-459-A, which develops about 60 volts negative bias across the grid leak of the amplifier stage, and an SX-24 receiver. It should work satisfactorily with any similar set-up.

— *W. H. Packer, W3HLK*

A VERSATILE 'PHONE MONITOR

Fig. 8-4 shows the circuit of a versatile unit that will find several uses in almost any 'phone station. It can be put to the following uses: (1) to monitor the audio quality of the signal; (2) to observe carrier shift and thus detect overmodulation; (3) to read (after calibration) average percentage modulation. The circuit is simple to construct, easy to adjust, and as reliable as most of the more expensive commercially-built gadgets of similar nature.

A dual triode is used, with one section diode-connected, the other serving as a Class A audio amplifier. A 0-1 d.c. milliammeter is switched to read either the plate current of the diode or the output of the audio amplifier.

To use the unit as a simple quality monitor, the pick-up antenna is loosely coupled to the output of the transmitter, and the tuned circuit resonated. R_4, and the coupling to the transmitter, then serve as a volume control. The meter switch should be set to Position 2 when this use is made of the unit. In this position, it reads the plate current of the diode, and also serves as a resonance indicator.

For observation of carrier shift, the same procedure is followed. Any change in the meter reading under modulation will indicate carrier shift.

When an oscilloscope is available, the unit may be calibrated to serve as a direct-reading per-

centage-modulation indicator. To calibrate, the unit is coupled to the transmitter, R_4 is turned all the way off, and the meter switch is placed in Position 2. The coupling is adjusted to provide a full-scale reading while the carrier is unmodulated. R_2 permits a fine adjustment of this reading. The meter switch is then set to Position 1, and sine-wave modulation is applied to the carrier. Observing the modulation at the same time on a 'scope, the audio level should be increased until the carrier is 100 per cent modulated. R_4 is then adjusted to provide full-scale deflection of the meter. Thus, the meter has been calibrated to read full scale on 100 per cent sine-wave modulation. When speech input is used on the transmitter, the meter will read only about 25 per cent of full scale at 100 per cent modulation. R_4 can be used to bring the meter to full-scale

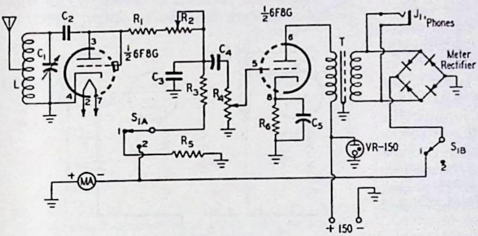


Fig. 8-4 — Circuit diagram for a versatile 'phone monitor that includes means of observing carrier shift and percentage of modulation.

C_1 — Receiving-type variable, suitable to tune desired range with *L*.
C_2, C_3 — 100-μμfd. mica.
C_4 — 0.01-μfd. paper.
C_5 — 20-μfd. 25-volt electrolytic.
R_1 — 33,000 ohms, ½ watt.
R_2 — 10,000-ohm potentiometer.
R_3 — 4700 ohms, ½ watt.
R_4 — 0.2-megohm potentiometer.
R_5 — Equal to meter resistance.
R_6 — 2200 ohms, 1 watt.
L — As required to tune to desired range with C_1.
J_1 — Open-circuit 'phone jack.
MA — 0-1 d.c. milliammeter.
S_{1A-B} — D.p.d.t. toggle switch.
T — 3:1 audio transformer.

deflection at 100 per cent *average* speech modulation by similar calibration against a 'scope, after which sine-wave modulation would cause the meter to read off scale. It should be remembered that the transmitter should never be modulated so heavily that the meter reads full scale, because while the *average* may be well under 100 per cent, *peak* speech values will be well in excess of 100 per cent, causing illegal splatter. Properly used, however, this unit can serve as a highly satisfactory indicator.

— *Wilf Moorhouse, VE7US*

THE "MONITONE" AS A 'PHONE MONITOR

The "Monitone" keying monitor described in September, 1948, *QST* and the 1949 *Handbook* may also be used for 'phone monitoring with a simple addition to the original circuit. Thus the gadget becomes doubly useful, and is a good bet for the man who operates both c.w. and 'phone.

Solder a lead from the positive side of the 1N34 crystal diode to the ungrounded side of the 'phone jack through a s.p.s.t. switch. To use the unit as a 'phone monitor, turn the power switch *off* and close the added switch. For c.w. monitoring, open the new toggle switch and use as described in the original article.

— *Paul Hescock, W1PRE*

"Q5-ER" AS VERTICAL AMPLIFIER FOR AN OSCILLOSCOPE

The "Lazy Man's Q5-er" (BC-453) makes an ideal vertical amplifier for an oscilloscope, and in so doing produces wave-envelope patterns of any signal the receiver is tuned to. The Q5-er is connected to the receiver in the usual fashion, and a lead is run from Pin 4 of the 12SR7 tube in the Q5-er to the vertical deflection plate of the 'scope tube. A linear sweep is needed, of course, but in most cases this will already be present.

In monitoring 'phone signals, percentage of modulation can be seen at a glance. Overmodulation, carrier hum, and the "make" and "break" characteristics of c.w. signals can also be observed. The connection to the 12SR7 does not interfere with normal functioning of the Q5-er.

— *A. T. Purseglove, W1QFB*

DUAL-TONE KEYING MONITOR

During a lonely watch aboard ship an idea for a unique type of audio keying monitor came to mind. Instead of a pure 500- or 1000-cycle note, this dual oscillator will produce a complex tone that brings joy to the heart of the brasspounder.

The idea, shown in Fig. 8-5, is simply to use the sections of a dual triode as separate audio oscillators, beating with each other. Their output is combined in a coupling transformer connected to 'phones or 'speaker. The tone is keyed by an open-type

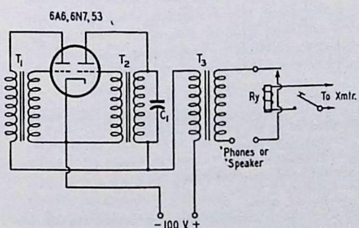


Fig. 8-5 — Dual-tone audio-oscillator keying monitor.

C_1 — 500 μμfd.
Ry — Normally open type s.p.s.t. relay to carry keying-circuit current through field coil.
T_1, T_2 — 3:1 audio transformers.
T_3 — Coupling transformer, 1:1, or may be same as others.

relay in series with the transmitter keying circuit. The field coil of the relay should be capable of carrying the normal load of the transmitter keying circuit.

It may not be necessary to use C_1, as most audio-transformer windings differ sufficiently to tune the separate oscillators to slightly differing frequencies, thus producing a complex tone.

— *J. C. Nelson, W2FW*

UNTUNED KEYING MONITOR

To eliminate the need for retuning the keying monitor every time transmitter frequency is changed, the gadget shown in Fig. 8-6 was designed. The entire set-up is simple, noncritical, and can be built compactly, permitting its use inside the receiver cabinet. There, out of the way, it does a nice job without readjustment no matter how often you QSY.

A 1N34 crystal detector is used to provide a small rectified voltage from the r.f. signal picked up on a short antenna placed near the transmitter. This voltage is then used to overcome an initial blocking bias on an oscillator tuned to the i.f. frequency of the receiver. The signal thus created appears in the rest of the receiver the same as any other c.w. signal, beating with the b.f.o. and producing any tone or volume that the operator may desire. The r.f. stages of the receiver are killed by rewiring the stand-by switch so that it removes B+ from them but permits the i.f. and audio stages to function normally.

In adjusting the unit for operation, the bias on the 6J5 must be set so that the oscillation is just triggered with each keyed character and is killed between characters. This is controlled by potentiometer R_4. The output condenser is merely clipped onto the grid of the first i.f. tube. Over-coupling to the i.f. grid will produce a signal rich in harmonics that is less tiring to the ear, but may detune the i.f. stage. The location of the cathode tap on the 455-kc. i.f. coil used as the oscillator inductance should be determined experimentally. Somewhat more than the usual "one-third up from ground" will give best results, assuring sufficient feed-back to permit the oscillator to follow fast keying. A fairly high-C circuit should be used here to obtain the degree of stability desired. Some experimentation may also be required to get the correct value for R_1. Too much resistance here will result in lack of rectified voltage, too little in excessive crystal current.

— *Rowland C. Medler, W4ANN*

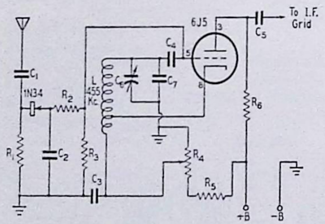


Fig. 8-6 — **An untuned keying monitor that may be installed inside the receiver cabinet.**

C_1 — 220-μμfd. mica.
C_2 — 0.001-μfd. mica.
C_3 — 0.01-μfd. paper or mica.
C_4 — 100-μμfd. mica.
C_5 — 5-μμfd. mica.
C_6, C_7 — As required to tune inductance to i.f. frequency of receiver.
R_1 — 1000 ohms, ½ watt.
R_2 — 0.47 megohm, ½ watt.
R_3 — 1 megohm, ½ watt.
R_4 — 20,000-ohm potentiometer.
R_5 — 0.1 megohm, ½ watt.
R_6 — 47,000 ohms, ½ watt.
L — 455-kc. i.f.-transformer coil, modified. (See text.)

AN AUDIO OSCILLATOR IN THE RECEIVER

Here's what I believe to be the simplest solution to the problem of setting up an audio oscillator to keep that fist in shape. Here's the

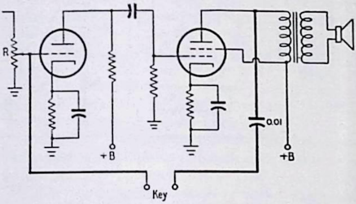


Fig. 8-7 — **Converting the audio amplifier of a receiver to an audio oscillator. The volume control, *R*, becomes the pitch control when the coupling condenser and key are wired in as shown by the heavy line.**

deal. Take any radio receiver, add a condenser (about 0.01 μfd.) and a key in series between the second a.f. plate and the first a.f. grid as shown in Fig. 8-7. The volume control, R, becomes a pitch control as it affects the feed-back. When the key is open, the receiver functions normally. There are no batteries, power supplies, or gadgets kicking around in the way — nothing but the receiver that was there in the first place.

— *James E. Shea*

RECEIVER B.F.O. AS KEYING MONITOR

It may not have occurred to some of those who have added a "Q5-er" to their communications receivers that the idle b.f.o. in the receiver may be used as a convenient keying monitor.

If oscillator cathode keying is used in the transmitter, the b.f.o. can be keyed simultaneously simply by tying the two cathodes in parallel, as shown in Fig. 8-8. Otherwise, the b.f.o. can be keyed with a relay.

If desired, the usual b.f.o. switch can be replaced with a s.p.d.t. switch, as shown at S_1, so that the b.f.o. can be switched from normal use to use as a monitor.

If the electron-coupled circuit is used in the b.f.o., as shown in Fig. 8-9A, the circuit may be keyed by parallel feeding the cathode as at B.

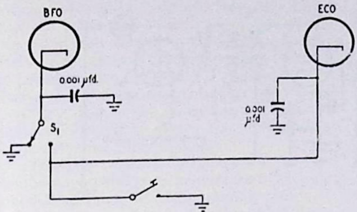
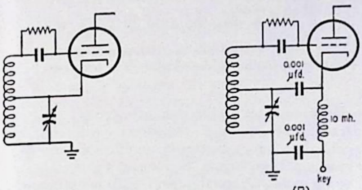
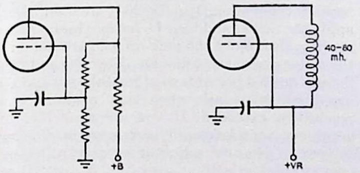


Fig. 8-8 — Keying the idle b.f.o. in a receiver that is used with a "Q5-er," to provide a keying monitor. In some receivers, it is merely necessary to tie the two cathodes in parallel, and install a switch to return the b.f.o. to its normal use when desired.



(A) (B)

Fig. 8-9 — If the receiver b.f.o. uses the electron-coupled circuit as shown at A, it may be keyed by parallel feeding the cathode as shown at B.



(A) (B)

Fig. 8-10 — In cases where dropping resistors in the b.f.o. circuit (A) result in a chirpy note when it is keyed, voltage regulation may be added as shown at B.

Usually the b.f.o. is operated at low voltage through dropping resistors, as indicated in Fig. 8-10A. These resistors may be responsible for a chirpy monitor signal. If this is the case, the chirp can be eliminated by operating the b.f.o. from a VR tube working from the receiver power supply as shown in Fig. 8-10B. The b.f.o. voltage should be checked first and an appropriate VR tube selected. A VR-75 will serve in most cases.

— *Don Mix, W1TS*

A FLASHER-TYPE PEAK-INDICATING MODULATION MONITOR

The purpose of this "kink" is to describe a simplified version of one of those expensive and complicated broadcast station monitors — the kind that flashes an indicator light every time the modulation on peaks exceeds a pre-set percentage.

The indicator operates by comparing the d.c. and a.c. components that result from the detection of a modulated carrier by a diode. The relationship between these voltages is such that the audio voltage is proportional to the percentage of modulation and just equals the d.c. voltage when the carrier is modulated 100 per cent. This relationship is independent of carrier strength, so a meter operating on the comparison basis will be independent of its r.f. input voltage and will operate with accuracy without readjustment for various transmitter input powers. [For a detailed explanation of the theory of operation the reader is referred to May, 1948, *QST*. —*Ed.*]

Fig. 8-11 gives the circuit diagram of this handy device. When plate voltage is applied C_6 charges to practically 250 volts through R_7 and R_9. R_8 and R_9 form a bias network similar to R_4 and R_5. R_9 is adjusted for cut-off, indicated by extinguishing the neon bulb. On modulation peaks V_2 conducts. It has in its plate circuit a transformer with the windings polarized so that the grid of the gas tube goes positive when the plate of V_2 starts to conduct. If the polarity of the transformer is reversed, the gas tube is driven more beyond cut-off and nothing happens. Trusting that you were lucky and the transformer secondary has been properly connected, the gas tube conducts, discharging C_6 through the neon bulb. Gas tubes have the characteristic that the grid no longer has any effect on plate current once the plate starts conducting, so the bulb remains lit until C_6 has discharged to the point where it no longer has enough voltage across it to maintain conduction through the gas tube and the neon bulb. R_7 is high enough in resistance so that sufficient current cannot be supplied to maintain conduction either, so the neon bulb becomes extinguished and the gas tube deionizes. The grid then regains control and C_6 leisurely charges up again while the circuit waits for another peak to come along. This whole cycle takes a short time and the bulb can flash brightly about twice a second. If another peak occurs before C_6 becomes fully charged, the flash will occur but will be of shorter duration; if the meter was set for 100 per cent modulation (using R_1), you had better back off on the speech gain because you are overmodulating. The length of the flash is independent of the modulation peak, because the gas tube loses control once it starts conducting.

It requires very little r.f. to operate the unit. A short piece of wire near the feeders, in the field of the antenna, or near the final tank, will pick up enough r.f. to swing the meter to nearly full scale. The larger the signal applied, the more accurate the flash indication will be.

No constructional data are given because parts locations are not critical and the builder will probably lay them out to suit himself in any event. The unit can be operated from the receiver power supply, can be built into the rig, can have its own power supply, or can otherwise be adapted to fit into the station arrangement. Any diode can be

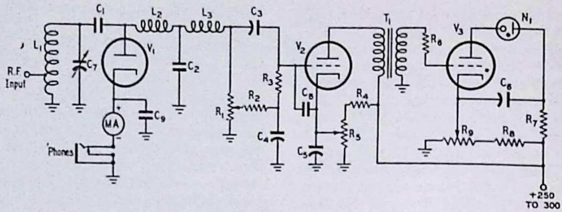


Fig. 8-11 — Circuit diagram of the flasher-type modulation indicator.

C_1, C_2, C_8, C_9 — 100-$\mu\mu$fd. mica.
C_3 — 0.01-μfd. 600-volt paper.
C_4, C_6 — 0.1-μfd. 600-volt paper.
C_5 — 10-μfd. 50-volt electrolytic.
C_7 — 100-$\mu\mu$fd. air variable.
R_1 — 50,000-ohm wire-wound linear potentiometer.
R_2, R_3 — 1 megohm, ½ watt.
R_4, R_8 — 0.1 megohm, 1 watt.
R_5, R_9 — 10,000-ohm potentiometer.
R_6 — 10,000 ohms, ½ watt.
R_7 — 0.22 megohm, ½ watt.
L_1 — Tune to operating frequency with C_7.
L_2, L_3 — 2½-mh. r.f. choke.
MA — 0–2 d.c. milliammeter.
N_1 — 115-volt ¼-watt neon bulb.
T_1 — Interstage audio transformer.
V_1 — Any diode.
V_2 — High-μ triode.
V_3 — Gas triode (884, 885, 2050, 2051, etc., triode-connected).
(V_1 and V_2 may be the two halves of a 6SL7, the half used for V_1 having grid and plate tied together.)

used for the detector, V_1, and this includes the crystal types such as the 1N34. The triode V_2 should be of the high-μ variety, so that cut-off voltage is low, resulting in better accuracy. The audio transformer can be any type of interstage transformer you may happen to dig out of the junk box, but you may have to reverse connections to the primary or secondary, as described earlier. The gas tube can be any of the types used for oscilloscope sweep generators, or one of the types used in relay circuits, such as the 2050 or 2051 (triode-connected). The potentiometer R_1 should be a wire-wound linear type. It can be calibrated and a special dial made, if you desire, by reading resistance with an accurate ohmmeter and marking the dial according to percentage of resistance between ground and the moving contact.

The meter *MA* indicates carrier shift, and the 'phone jack allows you to listen to your melodious voice as you call CQ, or gives you a chance to listen to the carrier when you are trying to locate the source of hum or distortion.

The tuned circuit L_1C_7 is left up to the builder. Coil-and-condenser combinations will depend on the band to be covered, and what the builder has on hand. The tap should be at about a third of the turns from the ground end.

The only precaution in construction is to isolate the grid of V_2 to prevent r.f. from getting into it. This causes inaccuracy when the grid gets down to nearly zero voltage. Isolation is not difficult, and r.f. probably will cause no trouble at all if a 100-$\mu\mu$fd. mica capacitor (C_8) is connected directly between grid and cathode. The unit in operation on the author's 10-meter 'phone rig uses one half of a 6SL7 for the diode and the other half as V_2, and no trouble was encountered so long as the mica r.f. by-pass was used.

Before applying any r.f. adjust the bias on V_2 so that the plate current is ¼ milliampere or less. A milliammeter can be connected directly across the primary of T_1 for this adjustment, since the transformer-winding resistance will be high enough to have practically no effect on the meter reading. Then adjust the bias on V_3, the gas tube, to the point where the neon bulb is extinguished but the bulb will flash when the grid lead is touched with a screwdriver. Touching this grid lead induces enough voltage through stray pick-up to trip the gas tube and flash the neon bulb. The value of R_7 *may* have to be increased when tubes of types other than the 2051 are used. Next, apply the carrier and tune C_7 for maximum meter reading, then move the pick-up lead around until the meter reads near full scale. Now R_1 can be set for any desired percentage of modulation and the neon bulb will flash when that modulation is reached or exceeded. If you are a stickler for accuracy, you might apply sine-wave modulation to your transmitter, adjust it for exactly 100 per cent as checked with a 'scope, set R_1 for 100 per cent and then adjust R_5 until the neon bulb just flickers. With the rough adjustment described earlier, the bulb may flash at about 95 per cent. Luckily, the error is in the legal direction and is of small magnitude.

The only caution in regard to adjustment is in connection with the point where the r.f. is picked up. If r.f. is picked up from some stage ahead of the modulated stage, the meter cannot flash at 100 per cent modulation because the r.f. can never reach zero, as it should, at the negative modulation peak. Once the thing is adjusted it probably can be operated indefinitely without readjustment. Mine has been operating for 18 months and is still accurate enough so that it isn't worth adjusting it. Perhaps when tubes are changed, adjustment should be made.

This instrument flashes the neon bulb when the modulation *down*-peak reaches the selected percentage. The instrument could have been designed to operate on up-peaks, but it was thought that "negative"-peak indication would be more

desirable. Inequality between "negative" and "positive" peaks can be seen by motion of the meter when the carrier is modulated (carrier shift). A slight flicker of the meter occurs when a strong peak causes the grid of V_2 to go positive and draw some grid current, but this is accompanied by a flash of the bulb, warning that the modulation is excessive. Correction of the modulation corrects the slight flicker.

The DX boys should find good use for this gadget because it will give them means of keeping the modulation right up there where it counts.

— *John S. Denham, W6NPO*

A PLUG FOR YOUR BUG KEY

Here is a practical homemade plug that I have used on my bug for the past four years. It may prove useful to other bug handlers.

My plug, shown in Fig. 8-12, was made from the tapered part of a discarded fountain pen. The closed end was sawed off, and the "works" inserted. I used two straight blades from an old 'phone jack and a flat piece of insulation cut just a little wider and about a quarter inch longer than the jack blades. The cord extends out the other end of the pen barrel after having been soldered onto the jack blades. Although it may not always be necessary, sealing compound or wax may be poured in to fill the area around the blades to hold

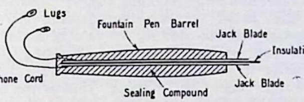


Fig. 8-12 — A plug for your bug.

them firmly in place. The cord is then attached to the bug using the lugs on the ends of the cord.

— *Wesley W. Brogan, W3ARM*

USING A PANORAMIC ADAPTER AS A MODULATION MONITOR

Here is a simple modulation-monitor idea for owners of panoramic adapters. A small d.p.d.t. relay operating from the transmit-receive switch in the transmitter is installed at the base of the 'scope tube in the adapter. The leads to the vertical deflection plates of the 'scope tube are disconnected and transferred to the normally closed pair of contacts on the relay. A pick-up loop and a link line, with a 0.001-μfd condenser in series, is then connected to the normally open pair of contacts, and is brought out so that it may be coupled to the final tank coil. The vertical deflection plates are then connected to the moving-arm contacts of the relay. No other changes are necessary.

The adapter operates normally in reception, but when the transmitter is turned on, the modulated r.f. envelope appears on the screen, permitting continuous monitoring of modulation. The position of the coupling link must be adjusted to give the correct pattern height.

— *Earl E. Ferguson, W5PAG*

VARIABLE INDUCTANCE FOR KEYING FILTERS

Here's a little stunt that may be old, but it does the job when a variable inductance is desired in your keying filter. In place of the usual iron-core choke, use the primary of a small 6.3-volt filament transformer as shown in Fig. 8-13.

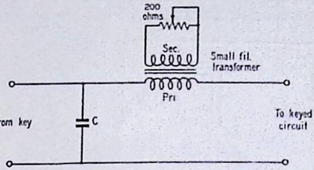


Fig. 8-13 — A method of obtaining a variable inductance for your key-click filter. A filament transformer is used in place of the usual choke, and the inductance is varied to suit your own taste by a resistor across the secondary.

A variable resistance of about two hundred ohms is connected across the secondary. By varying the resistance across the secondary, a continuous variation of the inductance of the primary is possible. When the secondary is completely shorted, the clicks come through just as though no inductance is in the circuit. The resistance can then be increased until the keying characteristic is as soft or hard as desired. The condenser value varies, of course, depending on the amount of current being keyed, as mentioned in the *Handbook*.

— *J. A. Turner, W9LI*

SPEED-KEY ADJUSTMENT

Correct sending with a semiautomatic speed key requires considerable manual skill which can only be acquired by practice. However, no amount of practice will produce accurate sending if the key itself is improperly adjusted.

The inked-line tape recorder provides an accurate and graphic means for "bug" adjusting. Such a recorder was described in *QST* [1] for April, 1943. Another method, using a milliammeter as an indicator, was described in *QST* [2] for February, 1934.

Preliminary Adjustments

The contact points should be carefully cleaned using a relay burnishing tool or crocus cloth. If the points are pitted, an initial dressing-off with an oil stone may be necessary, in which case care should be taken to keep the entire surface of the contact flat against the stone.

Occasionally a bug will sound "scratchy," particularly when keying an audio oscillator. If the dots are poor, the trouble is generally dirty or poorly-aligned contacts. If the trouble is on the dash side, it may be due to high resistance

[1] J. P. Gilliam, W9SVH, "A Siphon Tape Recorder . . .," *QST*, April, 1943.

[2] F. H. Schnell, W9UZ, "How's Your Fist?" *QST*, February, 1934.

between the dash lever and the shaft pivot. A flexible by-pass conductor from the dash contact adjusting screw to the frame should give a permanent cure.

Make sure that the movable and fixed dot contact points are parallel and have good contact over their entire surface. Horizontal adjustment of the movable dot contact is made by loosening the screw *L* (Fig. 8-14). Vertical adjustment is accomplished by means of the pivot bearings *J*. The pivot bearings should be adjusted so that no play can be felt when finger pressure is applied vertically to the shaft at its outer end.

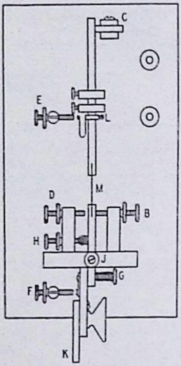


Fig. 8-14 — Critical points in adjusting a "bug."

For the preliminary adjustments, the weights should be at least halfway down the shaft. For a given speed, the exact position will vary considerably with the stiffness of the flat spring *M*.

Back off the screw *B* until the end of the shaft is resting against the damper weight *C*. Apply pressure to the thumb paddle *K*, moving the shaft slowly toward the dot side, without allowing it to vibrate. If the adjustment is correct, the entire shaft will remain straight as it leaves the stop screw and the damper weight. If screw *B* is backed off too far, the flat spring will bend to the left before the end of the shaft clears the damper weight. The stop screw should be backed out as far as possible to allow good damping action by the weight *C* without bending the flat spring when the thumb paddle is pressed slowly to the dot side. This adjustment is somewhat critical and should be carefully made.

Again press the shaft to the dot side without allowing it to vibrate. Vary the stop screw *D* until there is a gap of approximately 1/8 inch between the side of the shaft and the damper weight. This determines the swing of the shaft.

The dash adjustment is made by varying the screw *F* until the operating paddle moves the same distance to the left of center to make a dash as it moves to the right to make dots. If the paddle travel is excessive on the dash side, choppy sending is almost sure to result with spaces too wide between successive dashes. If the travel is too small, the dashes may be insufficiently spaced.

The coil springs *G* and *H* should be adjusted to approximately the same tension. This will vary with the individual operator, but in any case the spring *H* should have sufficient tension to return the shaft quickly and positively from the dot side to the rest position against the damper weight. The dash spring is then adjusted to a corresponding tension. Operators of fixed stations will generally prefer a comparatively light adjustment to minimize arm fatigue, particularly if a large amount of traffic is handled. Flight operators of Pan American Airways have found that a rather stiff adjustment is necessary; otherwise, when flying in rough air, sudden motions of the aircraft will result in unwanted dots. Marine operators will find that a medium stiff adjustment will compensate for the ship's roll.

Final Adjustment

The final adjustment of the dot contacts should be made with the bug operating a tape recorder, if available. The shaft is moved slowly to the left without allowing it to vibrate. The dot contact *E* is then moved to a position where it will just make contact with the movable point without noticeably bending the "U"-shaped dot spring. Start the recorder, pulling the tape through the machine at the rate of at least 20 feet per minute. Press the operating paddle smartly to the dot side. The resulting dots on the tape should be "square," that is the length of a dot should be equal to the space between two dots (Fig. 8-15C). If the paddle is held to the dot side, a series of at least 15 to 20 dots will be made with most bugs before there is any noticeable reduction in spacing between dots. If the dot adjustment is screwed in too far, a short series of heavy dots with very little separation will result, after which the points will remain in contact even though the shaft continues to vibrate. If the adjustment is screwed out too far, very light dots with excessive spacing will result. This adjustment is extremely critical, the allowable deviation of the screw *E* being only a small fraction of a turn.

With the recorder still operating, shift the weights along the shaft according to the speed desired. Many bugs are set to make excessively fast dots. It will be found that most keys having a normal stiffness in the flat spring can be operated at a speed of about 30 w.p.m. with

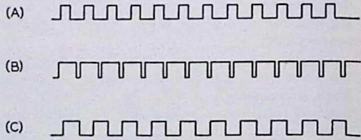


Fig. 8-15 — (A) Dot contacts too far apart. (B) Dot contacts too close. (C) Dot contacts correctly adjusted.

both weights toward the outer end of the shaft. Most operators cannot properly control a bug if the dot speed exceeds 11 per second. The rate at which your bug is adjusted can be easily determined by making a string of dots on the recorder tape for 3 to 5 seconds, timing with a stop watch, and counting the dots.

The milliammeter method of adjustment involves connecting a battery (or any suitable source of d.c.), rheostat, and milliammeter in series with the bug contacts. A typical set-up might employ a 22½-volt battery, a 1000-ohm rheostat and a 0–100 milliammeter. With the key contacts closed, adjust the rheostat (start with all the resistance in the circuit to avoid burning out the meter!) until the meter reads 100 ma. A string of dots is then produced with the bug and the average-current reading on the meter is noted. If the dots are too light, the reading will be less than 50 ma.; if too heavy, it will be more than 50 ma. The dot contact E is then adjusted, as previously described, until the meter reading hovers at approximately 50 ma. Any combination of voltage, resistance and milliammeter range may be used with this method, provided the meter reading noted during a string of dots is half that observed when the key contacts are held closed.

Obviously, there is no point in making dots faster than the operator is able to make dashes to correspond. The purpose of any telegraphic communication is to convey intelligence. Mistakes in sending have no meaning and confuse the receiving operator. The time taken to repeat an incorrectly-transmitted word will result in a net loss in speed of about two words per minute on the average. Set your bug for a speed at which you can handle it easily and without an appreciable number of errors.

Beginners with a bug, and some old hands too, will do well to imitate the 15-w.p.m. transmissions of W1AW or some press station using punched tape at moderate speed. Confine your practice to an audio oscillator until you are able to send correctly for at least two or three minutes at a rate of 20 w.p.m. During the initial practice stages, the dots should be slowed down to 6 per second. Every effort should be made at the start to achieve good control rather than speed.

— *J. M. Smith*

AN ELECTRONIC KEY OF ADVANCED DESIGN

Fig. 8-18 is the circuit diagram of an electronic keyer built around the principles described in detail by the author in October, 1948, *QST*. The device features self-completing dots and dashes, single-control speed adjustment, and a simple keying lever. Exact circuit values are given to enable duplication.

Operating grid bias is obtained by means of the two divider networks made up of R_7R_8 and R_9-$R_{10}R_{11}$. R_3 and R_5 prevent excessive change in grid-input impedance with variation of the speed-control resistor, R_4. C_3 and R_6 furnish necessary grid-input stabilization. R_3 also serves to fix the

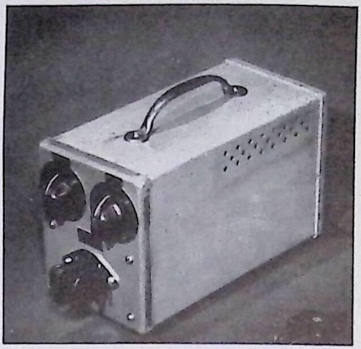


Fig. 8-16 — The completed electronic keyer occupies little more table space than a conventional bug.

maximum operating speed by limiting the current flow through R_4. Maximum resistance of the latter sets minimum speed. Values shown provide a range of approximately 12 to 50 words per minute. R_1 in series with the movable contact of the key lever limits the instantaneous discharge current of the timing network. This minimizes sparking both at the key lever and pulsing-relay contacts. R_{10} is used to vary the bias on V_2 by controlling the bleeder-current flow through R_9. This allows the weight of the keying to be varied to suit the operator's wishes. In addition, it is of advantage in compensating for differing characteristics when tube replacements are made.

High-quality condensers should be used at C_1, C_2 and C_3. Standard-make 600-volt tubulars were used in the keyer illustrated. C_1 consists of 0.05- and 0.1-μfd. units in parallel to give the required 0.15-μfd. capacitance. No particular com-

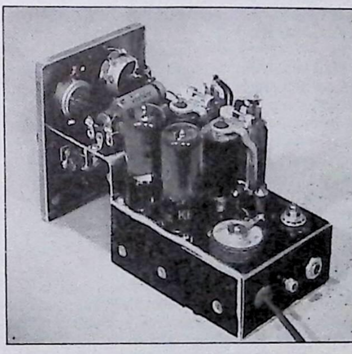


Fig. 8-17 — Interior view showing the mounting of tubes, relays and other major parts.

ment need be made on the power supply which uses a standard 100-ma. selenium rectifier. The 150-ohm resistor in the filament circuit drops the voltage to a safe operating value for the 50L6s. The two relays constitute the most critical components in this circuit. These should be identical and of fixed-adjustment wiping-contact design. Coil resistance, of course, must be suitable for vacuum-tube operation. So-called "sensitive plate-circuit" relays of the type having numerous adjustments should be avoided. In the experimental keyer shown in the photographs, the author used 3500-ohm Clare relays. However, any good telephone-type relay with proper contact and coil specifications should be satisfactory.

It is important that relay contact spacing be set at 0.010 inch, as measured between the movable contact and the "make" contact. To set this spacing, use a feeler gauge and carefully bend the "make" contact arm. The overtravel of the relay armature should be sufficient to give moderate wiping action on both the forward and back contacts.

The setting of R_2 in the timing circuit for the correct dot-dash ratio must be made by monitoring a circuit keyed by Ry_2. First, set R_2 at minimum resistance and with the key lever held to the dash position, set the speed control R_4 at about one-quarter scale beyond the point where the keying relay picks up. The speed control should be set at about two-thirds scale. Now, advance R_2 and at the same time swing the key lever alternately from the dot position to the dash position. To the average operator's ear, the point where the dot-dash ratio is about right is readily and easily determined. Once set, the timing circuit needs no further attention. The dot-dash ratio of the keyer will remain true at all sending speeds.

The photographs show how the electronic keyer is built to occupy a minimum of space at the operating position. The construction is compact but not overcrowded. A semiautomatic-key assembly was altered to serve as the control lever. Aside from the portability angle, the author favors a design wherein the keyer is built as a unit separate from the key lever. This makes for a more orderly operating position — since one advantage of a keyer of this type is the simple lever required. Lead length is not critical and the keyer unit can be incorporated right in the exciter unit or transmitter proper. A semiautomatic key can be converted to single-pole double-throw action in a matter of minutes. The shorting connection between the stationary dot and dash contacts is removed and the vibrating arm is locked by strapping it to its backstop with a rubber band.

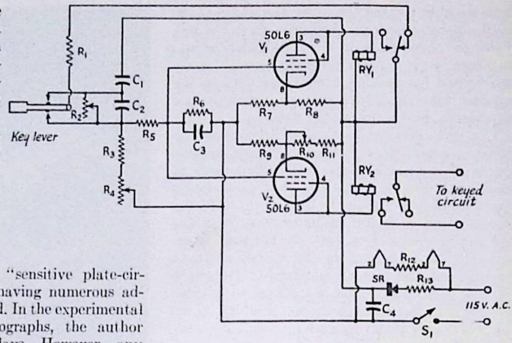


Fig. 8-18 — Practical keyer circuit.

C_1 — 0.15-μfd. 600-volt paper.
C_2, C_3 — 0.05-μfd. 600-volt paper.
C_4 — 40-μfd. 150-volt electrolytic.
R_1 — 470 ohms, ½ watt.
R_2 — 0.5-megohm variable (dot-dash ratio control).
R_3, R_5 — 0.22 megohm, 1 watt.
R_4 — 2-megohm variable (speed control).
R_6 — 2.7 megohms, ½ watt.
R_7, R_9 — 2200 ohms, 1 watt.
R_8 — 10,000 ohms, 2 watts.
R_{10} — 5000-ohm variable (shaping control).
R_{11} — 6800 ohms, 1 watt.
R_{12} — 150 ohms, 5 watts.
R_{13} — 39 ohms, 1 watt.
Ry_1, Ry_2 — Sensitive-type relay (Clare Type J, 3500 ohms, s.p.d.t.).
S_1 — S.p.s.t. toggle.
SR — 100-ma. selenium rectifier.

Contacts are then adjusted to give the desired s.p.d.t. action.

In closing, the writer wishes to acknowledge, with thanks, valuable suggestions contributed by A. R. Burns of Highland Park, Calif., in the development of certain portions of the circuit described.

— *F. A. Bartlett, W6OWP*

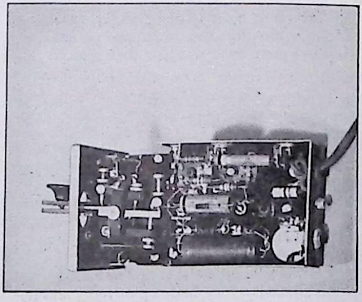


Fig. 8-19 — This bottom view of the electronic keyer shows a compact but orderly arrangement of the minor components.

9. Hints and Kinks . . . for Test Equipment

FIELD-STRENGTH METER WITH ADJUSTABLE ANTENNA

HERE IS A simple and handy type of field-strength meter for use on any frequency up to 1000 Mc.

This unit has only four main components: a 6-foot flexible roll-up type steel rule, a high-frequency crystal, a d.c. microammeter and a copper ground plate in the bottom of a wooden box. The crystal is connected in series with the ruler and the ground plate, and the meter is connected in parallel with the crystal.

As shown in Fig. 9-1, a small plywood box was constructed with a sloping front panel and with a carrying handle on the top. The flexible roll-up ruler pulls up out of a slot in the top of the box to the required height to give a sufficient deflection on the meter. Pin jacks on the front panel permit the easy placement of shunt resistors across the meter to reduce its sensitivity. (A 0–1 milliammeter has been used in place of the 0–30 microampere meter with some sacrifice in sensitivity.)

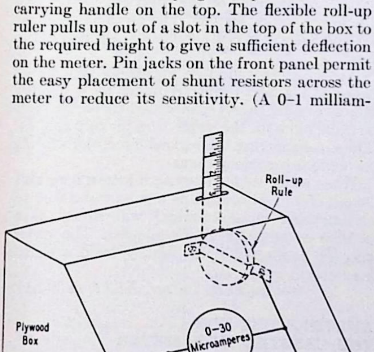


Fig. 9-1 — An X-ray type drawing depicting the connections made in the field-strength meter. Note the counterpoise, a copper ground plate in the bottom of the compartment.

A meter such as this is very handy for tuning up an u.h.f. antenna or transmitter and also may be used to check relative field strengths and directional characteristics of the antenna.

Its use is not limited to u.h.f., and the unit shown here has received as much use in adjusting an airplane transmitter on 3150 kc. as it did in connection with a television antenna on 900 Mc.

This simple meter should not be confused with a wavemeter having a tuned circuit as this one is in no way selective as to frequency. It's a mighty handy gadget, just the same.

— *Philip S. Rand, W1DBM; Harry S. Whittemore, W1BR; and Joseph H. Marchese*

FIELD-STRENGTH MEASUREMENTS WITH A VOLT-OHMMETER

AFTER pondering for some length of time in an effort to avoid having to build a permanent field-strength meter to tune a beam antenna, the following brain child resulted.

Using your volt-ohmmeter, or a 0–1 ma. meter, tie a 1N34 crystal diode across the ends of the test leads where they enter the meter box. Place the ohmmeter, with the leads attached, a half-wavelength or more from the antenna that is to be adjusted. Spread the test leads out on the ground to resemble a dipole with the ohmmeter at the center. Set the ohmmeter to the 0–1 ma. scale, aim the beam at the meter, and turn the transmitter on. The position of the meter may be changed to provide more, or less, deflection of the meter as required. Beam adjustments can then be made as usual.

If the meter registers backward, reverse the connection of the crystal diode. Variations on this may consist of lengthening the test leads to a total length of a half-wave at the operating frequency to increase the "deflection sensitivity" of the set-up. A remote-indicating device may be made by using Twin-Lead to connect a pick-up dipole at some distance to an ohmmeter located at the beam to make one-man adjustment possible.

— *Frederick L. Moore, W4JYB*

FULL-WAVE CRYSTAL-RECTIFIER FIELD-STRENGTH METER

INCREASED sensitivity can be obtained in the crystal-type field-strength meter by employing two crystals in a full-wave circuit and a microammeter instead of the more common milliammeter. Thus observations can be made with this tubeless instrument at a greater distance from the station transmitting antenna than is possible with single-crystal field-strength meters.

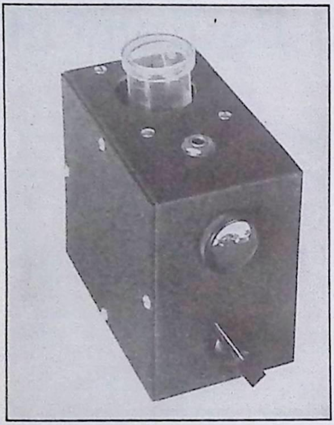


Fig. 9-2 — This field-strength meter, weighing only a few ounces, is small enough to be held comfortably in one hand. It requires no power supply.

The complete circuit schematic is given in Fig. 9-3. Each half of the center-tapped secondary, L_2, is tuned separately by a section of the dual variable capacitor, C_1. A closed-circuit headphone jack, J_1, is provided for aural monitoring of a modulated signal, but headphones should be removed from the circuit when using the microammeter. Six plug-in coils are used to cover the range of 3.5 to 200 megacycles.

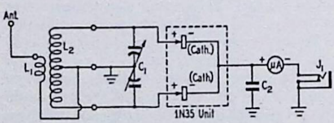


Fig. 9-3 — Circuit of the full-wave crystal-rectifier field-strength meter.

C_1 — 50-μμfd.-per-section midget variable.
C_2 — 0.0022-μfd. mica.
L_1, L_2 — See coil table.
J_1 — Miniature closed-circuit 'phone jack.
μA — 1-inch d.c. microammeter, 200-μa. scale (International Instruments, Inc., New Haven, Conn.).
1N35 — Dual-crystal-diode assembly — Sylvania.

The device is built in a 3 × 4 × 5-inch steel box and is small enough to be held in one hand. The coil socket is mounted on a small piece of aluminum suspended from the top edge of the box on metal pillars at the corners. A clearance hole is cut for the coil so that it may be removed from the top. The tuning condenser is fastened to the front edge of the box. Since the writer did not intend to use the instrument for frequency measurement, the condenser was fitted with a plain knob, but a small dial such as the National type AM may be used if calibration is desired.

COIL TABLE

Dimensions for L_2, Fig. 9-3

3.5–7 Mc. — 86 turns No. 26 enam., close-wound.
7–14 Mc. — 36 turns No. 24 enam., close-wound.
14–28 Mc. — 20 turns No. 22 enam., 1 inch long.
28–54 Mc. — 12 turns No. 22 enam., 1 inch long.
50–100 Mc. — 5 turns No. 22 enam., 1 inch long.
100–200 Mc. — 2½ turns No. 22 enam., 1 inch long.

L_1 in all cases is 1 turn No. 24 wound in space between halves of L_2 (see text).

The double-diode crystal unit is a Sylvania type 1N35, but two individual 1N34s may be substituted if preferred. The crystals are wired in between the tuning condenser and the headphone jack in front of the coil opening. The microammeter is a one-inch instrument with a 200-μa. scale. It is mounted on the front edge of the box above the tuning control. The antenna terminal is a small feed-through insulator at the rear of the box.

The coils are wound on Amphenol type 24-4P four-pin 1¼-inch forms. Winding L_2 is divided into two equal halves spaced slightly on the form to leave room for the single-turn pick-up coil, L_1. The accompanying table gives dimensions for L_2 for various frequency ranges.

When using the field-strength meter, a vertical length of stiff wire, such as bus bar, attached to the antenna input terminal will suffice as a pick-up antenna on all frequencies. The meter may be calibrated in frequency from a signal generator.

— *Rufus P. Turner, K6AI, ex-W1AY*

ANOTHER USE FOR THE CRYSTAL WAVEMETER

FOR those who have built the crystal-diode absorption wavemeter described in the *Handbook*, Fig. 9-4 shows a method of using it as a sensitive r.f. indicator for tuning antenna systems. The plug-in coil of the wavemeter is removed from its socket and in its place a plug made from an old tube base is inserted. The plug is connected to any convenient length of 72-ohm Twin-Lead. Battery clips may then be used to tap the line across the shorting bar of a stub or at the center of the antenna. The antenna being adjusted should then be loosely coupled to a near-by dipole

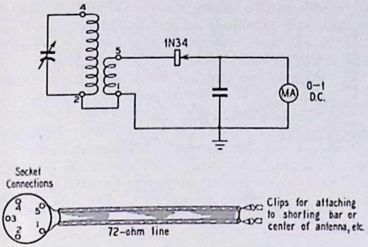


Fig. 9-4 — A method of using the sensitive crystal wavemeter as an r.f. indicator for antenna adjustments. The tuned circuit of the wavemeter is replaced by any convenient length of 72-ohm line. No internal changes are required.

that is connected to the transmitter. Very little power will be required to get a usable indication on the milliammeter. Matching adjustments on the antenna may then be made, observing the results on the meter. It should be noted that the indicator should never be connected to a portion of the antenna that is above r.f. ground potential, as it would then add capacitance and unbalance, destroying the meaning of any reading obtained.

— *George S. Woods, W2SWN*

MEASURING GALVANOMETER RESISTANCE

It is sometimes necessary to measure the resistance of a deflection galvanometer or microammeter when no other meter is available. This can be done very simply, using the instrument to be measured as its own current-indicating device. The other apparatus required consists of a fixed resistor, a calibrated variable resistor or decade box, and a battery cell, connected as shown in Fig. 9-5.

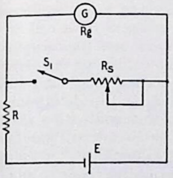


Fig. 9-5 — Measuring the resistance of a meter by utilizing the meter itself as the current indicating device. See text for component values.

The voltage of the battery should be such that R is large compared with the expected value of R_g, the quantity to be measured. R is then chosen to limit the current through the galvanometer to a safe value, preferably near full-scale deflection. R_s must be capable of adjustment to a resistance at least equal to the expected value of R_g. The battery voltage need not be accurately known, but R_s must be known to the same decimal (not *per cent*) accuracy by which it is desired to determine R_g.

With S_1 open, read the current through the galvanometer on its scale. Close the switch and adjust R_s until the reading on G is exactly one-half of the first reading.

If R is large, 100 times or more the value of R_g, then the setting of R_s has the same value as R_g with a small error. For the general case where R is not so large, or to determine the exact value, R_g may be found by application of the formula

$$R_g = \frac{RR_s}{R - R_s}.$$

— *E. M. Yard*

SOME HANDY TEST PROBES

A set of inexpensive test probes using small lamps have been found convenient on my workbench, and they can be carried in the pocket when necessary.

In Fig. 9-6A, a probe which can be used as an ohmmeter is shown. It requires two penlight cells and a pilot lamp such as the Sylvania S48, rated at 0.06 ampere at 2 volts. The lamp will light dimly at about 0.7 volt and about 0.03 ampere. Thus with a 3-volt supply this probe can be used to test circuits with resistances up to about 75 ohms. This range includes many of the coils, transformers and other circuit components commonly encountered. In testing low-resistance leads the current rating of the lamp will be exceeded, although it should "take it" if flashed only momentarily.

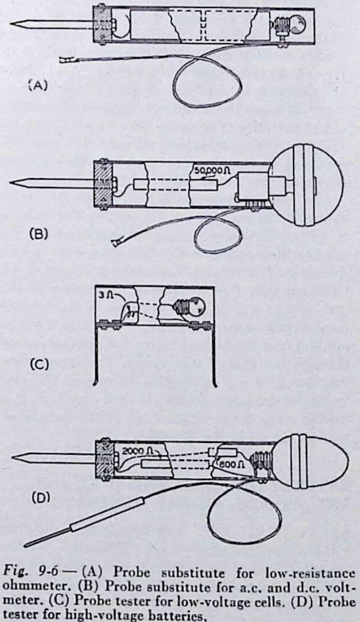


Fig. 9-6 — (A) Probe substitute for low-resistance ohmmeter. (B) Probe substitute for a.c. and d.c. voltmeter. (C) Probe tester for low-voltage cells. (D) Probe tester for high-voltage batteries.

The probe of Fig. 9-6B may be described as a substitute voltmeter for a.c. or d.c. It uses a neon bulb such as the GE type G10, with no resistor in its base. The bulb is connected in series with a 50,000-ohm 1-watt resistor. The starting voltage is about 65 volts, d.c., and 50 volts, a.c. The resistor limits the current to a safe value up to about 400 volts. If too high a voltage is used an arc will start between the elements of the tube. The relatively high impedance of this probe permits its use as a substitute for a voltmeter for testing circuits. It readily determines type and polarity of voltage. On a.c. both elements of the tube will glow. On d.c. that element which is connected to the positive side of the circuit glows. As the brilliancy of the glow increases with the voltage, a rough estimate of the voltage is possible.

The probe shown in Fig. 9-6C is convenient for testing "A" batteries under load, which is supplied by the coil of resistance wire shown in the diagram. For testing flashlight cells the load may be about 3 ohms and the bulb rated at 1.5 or 2 volts.

A probe used for testing "B" batteries is shown in Fig. 9-6D. A 6-watt 115-volt bulb is used, connected in series with an 800-ohm ½-watt resistor. Because of the nonlinear current characteristics of metallic-filament lamps, it is difficult to estimate changes in voltage by the brightness of the filament. The 800-ohm resistor in series with the filament tends to increase the linearity of the circuit, thereby making it easier to spot a low-voltage battery by a change in the brightness of the filament. A test load is supplied by a 2000-ohm 1-watt resistor shunted directly across the battery. A 45-volt battery in good condition causes the filament to glow red. A good 22½-volt battery will cause the filament to glow at the threshold of visibility. The probe may be used momentarily on a 90-volt battery, although the load current will be increased to a point which greatly overloads the 1-watt resistor.

The general construction of these probes is shown in the drawings of Fig. 9-6. In the cases of A, C and D, ⅝-inch diameter bakelite tubing is used as the housing, and in the case of B, ⅞-inch diameter. The point of the probe is a ⅛-inch rod threaded into a plug which is fastened into the end of the tubing with screws. A convenient method of mounting the bulbs is to solder a nut or binding post to the base to receive a screw passed through the wall of the tubing. The same screw may be used for connection to one of the test leads. As the larger bulbs are easily broken, it is well to wrap them with a turn or two of rubber tape as shown in the drawings.

— *Robert C. Paine*

BATTERY-POWERED ONE-TUBE 450- AND 1500-KC. SIGNAL GENERATOR

Here at our ATC Headquarters, I do the radio servicing work for our Special Service section as well as the majority of the work on the fellows' personal radio sets. I needed a small signal generator and tried out one originally designed by P. W. Winsford, G4DC. After slight

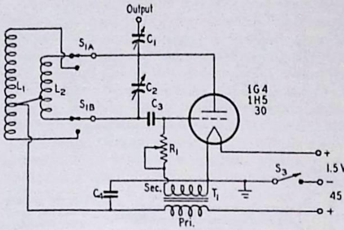


Fig. 9-7 — A battery-powered signal generator for 450 and 1500 kc.

C_1 — 3-30-μμfd. trimmer.
C_2 — 500-μμfd. variable.
C_3 — 100-μμfd. mica.
C_4 — 0.0022-μfd. mica.
R_1 — 1-megohm potentiometer.
L_1 — 140 turns No. 30 d.s.c. on 1¼-in. form (450 kc.).
L_2 — 42 turns No. 20 d.s.c. or enameled wire on 1¼-in. form (1500 kc.).
$S_{1A\text{-}B}$ — D.p.d.t. toggle or rotary switch.
S_3 — S.p.s.t. toggle switch.
T_1 — Audio transformer.

modifications the circuit now appears as shown in Fig. 9-7. The location of the taps on the coils was determined by experiment. The unit was calibrated for 1500 and 450 kc. by checking with a Super-Pro. The signal output is brought out of the cabinet through a three-foot shielded lead.

— *Maj. Joseph D. Andrew, Chaplain, USA, W4EFG*

A TRANSITRON UTILITY OSCILLATOR

The wide-range transitron oscillator circuit shown in Fig. 9-8 serves a multitude of purposes around the ham shack, providing a simple means of measuring small capacitances, determining the resonant frequency of any coil with a known capacitance across it, and even measuring the stray capacitances present in an oscillator.

The circuit will oscillate whenever a coil or a resonant circuit is connected across the terminals marked *L* in Fig. 9-8. The calibrated condenser provides a method of measuring small capacities by the substitution method, and of determining the resonant frequency of any coil with a given amount of *C* across it. The circuit will oscillate with almost any value of inductance; for example, anything ranging from a filter choke to an i.f. transformer. The oscillator can be made to operate over a frequency range of about 20 c.p.s. to 10 Mc.

The 6SJ7 tube forms a conventional transitron oscillator, while the 6E5 magic-eye tube serves to indicate oscillation. Since the screen current for the 6SJ7 must flow between the *L* terminals, a d.c. path between these terminals must always be provided.

In use, the magic-eye angle is set to some convenient position by adjustment of the grid-bias control, R_1. Then a coil, or a coil-and-condenser combination, is connected between the

L terminals. Oscillation will produce fuzzy edges on the eye shadow, and may change the shadow angle. The frequency of oscillation may then be determined by any convenient method, such as an absorption wavemeter, heterodyne frequency meter, or a calibrated receiver. If a resonant circuit, such as an i.f. transformer, is to be checked for frequency, the jumper to the calibrated condenser should be removed. Allowance should be made for the distributed capacity across the L terminals, including internal tube capacities and stray wiring capacities.

The circuit may be used as a simple oscillator at any frequency within its range by winding a coil of suitable inductance for the frequency range desired and connecting it across the L terminals. It is then tuned to the exact desired frequency with C_5. If the L/C ratio is kept within reasonable limits, the harmonic content will be very low. For example, with the set oscillating at 1 Mc., only the first six harmonics were audible on a near-by communications receiver. An old filter choke was found to be self-resonant at about 1300 cycles. Adding a little extra capacity caused it to be resonant at about 160 cycles.

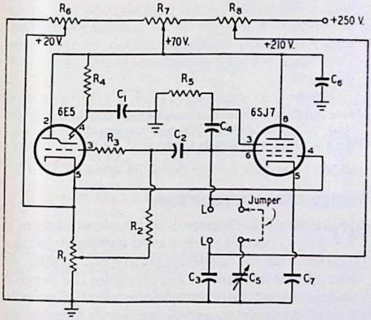


Fig. 9-8 — A wide-range transitron utility oscillator for the ham shack. The sliders on R_6, R_7 and R_8 should be adjusted to give the voltages shown in the diagram.
C_1, C_7 — 0.25-μfd. 600-volt paper.
C_2 — 0.02-μfd. 600-volt paper.
C_3, C_4, C_6 — 0.1-μfd. 600-volt paper.
C_5 — 350-$\mu\mu$fd. receiving-type variable.
R_1 — 2000-ohm potentiometer.
R_2, R_4 — 1 megohm, ½ watt.
R_3 — 0.18 megohm, ½ watt.
R_5 — 0.1 megohm, ½ watt.
R_6, R_8 — 1200 ohms, 10 watts, with slider.
R_7 — 7000 ohms, 10 watts, with slider.

The capacity of a small condenser may be found by noting the change of the calibrated-condenser capacity required to keep the oscillator signal in tune (b.f.o. on) on a receiver when the unknown condenser is connected across a coil at the L terminals. Larger capacities may be determined by measuring the frequencies with and without the unknown capacity shunted across the coil, and then calculating the unknown capacity from the bandspread-condenser formulas. Similarly, the stray capacity of the oscillator circuit may be computed using the calibrated condenser to give a known capacity change.

— *Henry L. Cox, jr.*

A CATHODE-COUPLED OSCILLATOR

The circuit shown in Fig. 9-9 is that of a two-terminal oscillator, known as a "cathode-coupled" oscillator, "first cousin" of the "cathode-coupled" multivibrator. It is easy to construct, simple to adjust, and the circuit (except for the LC tank) will oscillate from 20 *cycles* to 80 *megacycles* by attaching the proper LC circuit at points A and B. The top limit of one test set-up (a 6J6 without r.f. chokes in the heater) was approximately 208 Mc. Bandswitching may be accomplished easily, as only one "hot" lead need be switched.

The only critical value is R_k which should be between 1000 and 3000 ohms. Less than 1000 ohms will result in a poor waveform (observed at 50 kc.). A value greater than 3000 ohms will cause reduced output, but with an improved waveform when used with low-Q tank circuits. The tuned circuit looks into a cathode follower which results in light loading. The cathode waveform consists of pulses and is high in harmonic content.

This oscillator can be grid-modulated by injecting an audio voltage on Grid 2 using a transformer by-passed for r.f. Distortion sets in with over 30 per cent modulation and attempts to modulate 100 per cent resulted in pulsed output.

A quartz crystal can not be successfully tied in at A-B to give crystal results. The circuit will oscillate or multivibrate at the natural frequency of the resistor or r.f. choke used as a grid return. For crystal control, the crystal must be added at C_c, or separate cathodes may be connected together by a crystal. This is satisfactory for low-frequency crystals where the unit may be operated as a stabilized multivibrator. In either case, the LC circuit or RC time constant must be near the crystal frequency. If the LC circuit is placed in the amplifier plate, Miller-effect frequency modulation obtains by modulating Grid 2.

Oscillation is persistent. Keying is excellent at 10 Mc. using a 6J6 tube with four volts

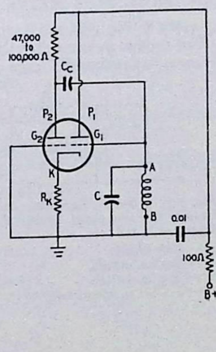


Fig. 9-9 — A cathode-coupled oscillator. The cathode resistor, R_k, should be between 1000 and 3000 ohms. Suitable LC combinations are connected between Grid 1 and ground to produce oscillations ranging from 20 cycles to 80 megacycles. Twin triodes, such as the 6J6, are useful in this circuit.

on the heater and only *three volts* on the plate.

Stability measurements were made at 50 kc. where good observations could be made on my 'scope. Changes in plate voltage from 150 to 50 (on a 6SN7GT) caused a frequency change of only 0.1 per cent.

Original references to this circuit were obtained from an article by F. Butler presented in the November, 1944, issue of *Wireless Engineer*.

— *Frank C. Alexander, jr.*

A CONDENSER CHECKER AND OUTPUT METER

An easily-constructed condenser checker and output meter is shown in Fig. 9-10. I used a 2E5, but a 6U5 or a 6E5 would work just as well. Provision is made for two sets of test prod connections. Prods *A* are used for checking condensers, either paper or electrolytic. Prods *B*

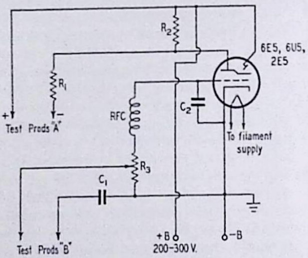


Fig. 9-10 — Condenser checker and output meter using a "magic eye" tube. R_1 is adjusted until shorted prods *A* will close shadow. R_2 is 1 megohm. R_3 is a 100,000-ohm potentiometer. C_1 and C_2 are 0.01-μfd. 600-volt. The r.f. choke was salvaged from an old b.c. receiver.

serve as an output meter or signal tracer, in the a.f. portion of a receiver. The value of R_1 (about 3300 ohms) is adjusted until the shadow just closes with prods *A* shorted. R_3 is a gain control. The condition of condensers can be determined after a little practice. The polarity of the prods should be observed in checking electrolytic condensers.

— *L. R. Hecox, W7FGB*

AN IMPEDANCE METER

Shown in Fig. 9-11 is a handy gadget that can be used to measure directly the impedance of chokes, transformers, large paper condensers,

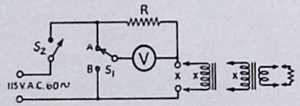


Fig. 9-11 — Simple impedance-measuring gadget. Unknowns are compared against known resistances as described in the text.
R — 4000 ohms.
S_1 — S.p.d.t. switch.
S_2 — S.p.s.t. switch.
V — 0-150 a.c. voltmeter.

etc. Measurement of that unknown output transformer will be a simple job with this unit, and although its accuracy is not perfect, it is close enough to make it a welcome addition to any ham shack.

The principle of operation is explained by Fig. 9-12. The voltage is measured across a known

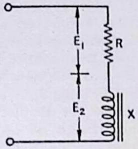


Fig. 9-12 — The basic circuit used in the impedance-measuring unit.

resistance *R*, and then across the unknown impedance *X*. Then by application of the formula $Z = RE_2/E_1$ you have the impedance in ohms, or a reasonable facsimile thereof, of the unknown. By the use of an inductance-capacitance-frequency chart, measurements can be converted easily to henrys or microfarads.

When measuring transformers, the secondary or the winding not under test must be loaded with a resistor of the value of the winding. Hence the 4-ohm voice coil of an output transformer under test must be loaded with a 4-ohm resistor if accurate primary-impedance readings are to be obtained.

The unit in use at my shack is built in a small steel utility box, and the formula has been simplified to $Z = 4000B/A$ and marked on a card which is pasted just above the meter.

— *Kit H. Carlos, W8MJB*

GRID-DIP OSCILLATOR

One piece of equipment which does not seem to have attained its deserved popularity among amateurs is the grid-dip oscillator. Among the uses of this instrument are checking the resonant frequencies of tuned circuits (without the necessity of applying power to the circuit), measuring inductance and capacity, and finding the resonant frequencies of antenna systems. A simple version of the grid-dip oscillator which will be found very useful around the average ham shack is shown in Fig. 9-13. A 6E5 "magic eye" tuning indicator has been substituted for the usual milliammeter to indicate change in grid current. Besides being cheaper, it is extremely sensitive, and is immune to damage from overload. A 6J5 is used as an ordinary Hartley oscillator, with the 6E5 connected to indicate oscillator grid voltage. When power is absorbed from the tank circuit by another circuit tuned to the same frequency, a sharp indication is obtained on the tuning eye. With its help, a new transmitter can be closely tuned up before applying any power at all.

The unit becomes a sensitive absorption wavemeter when switch *S* is opened, giving a much more accurate indication than can be obtained with the usual pilot bulb, and yet without fear of damaging an expensive meter. By plugging a pair

of 'phones into the closed-circuit jack, the unit can be used as a diode monitor or oscillating detector (with the plate switch *off* and *on*, respectively). For checking the natural frequency of an antenna, it will be found convenient to couple the coil to the antenna by means of a link line, as described in the *Handbook*. The method of measuring C and L is also adquately described therein. Calibration curves for each coil range can be made with sufficient accuracy for most normal work, but in any case, the oscillator frequency can be measured with fair accuracy by

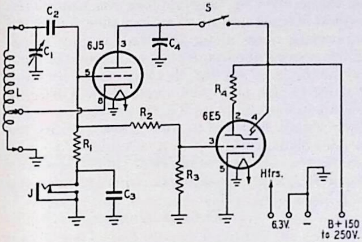


Fig. 9-13 — A grid-dip oscillator for general utility in the ham shack.

C_1 — 150-μμfd. midget variable.
C_2 — 220-μμfd. mica.
C_3 — 0.001-μfd. mica.
C_4 — 0.01-μfd. paper.
R_1 — 0.1 megohm, ½-watt carbon.
R_2 — 4.7 megohms, ½-watt carbon.
R_3, R_4 — 1 megohm, ½-watt carbon.
L — (2.5–7 Mc.) 29 turns, tapped at 1 turn, 1¼-inch diam.
(6–14 Mc.) 12 turns, tapped at 1 turn, 1¼-inch diam.
(12–35 Mc.) 5 turns, tapped at ¾ turn, 1¼-inch diam.
(30–60 Mc.) 3 turns, tapped at ½ turn, ½-inch diam.
J — Closed-circuit 'phone jack.
S — S.p.s.t. toggle switch.

tuning it in on the station receiver. A standard 3 × 4 × 5 metal box makes a convenient housing for all parts, with the coil plugged into a socket on one end, and the tuning-eye screen visible through a hole in the top.

— *R. V. McGraw, W2LYH*

A VACUUM-TUBE VOLT-OHMMETER

Most radio amateurs and servicemen are finding it hard to obtain the more elaborate and expensive testers. The circuit shown in Fig. 9-14 may be found of value in the construction of a simple and practical unit for use with other test equipment on hand, filling the need for a high-range ohmmeter and high-impedance input voltmeter for testing station apparatus. The basic microammeter required may be that in the regular volt-ohmmeter which every amateur should have available. The 200-microampere meter used in this volt-ohmmeter was originally obtained from a General Electric photocell light meter and is now also serving in a portable volt-ohmmeter of conventional design.

The entire v.t.v.m., including batteries, should be built up in a metal case to prevent leakage to the circuit under test, which might occur with a wooden cabinet. The unit is readily portable and light in weight if small batteries are used.

As seen in Fig. 9-14, the unit can be used as an a.f. signal tracer by plugging 'phones or a magnetic speaker into J_5, in place of the meter, and connecting the input to J_3 and J_4. This assumes that the tube is operated sufficiently high on the linear portion of the E_gI_p curve so that audio distortion is not excessive. If the tube is biased near the cut-off point the a.c. sensitivity will be slightly greater, but the unit cannot then be used successfully as a signal tracer in a.f. circuits except with a meter as the indicator.

The 20,000-ohm potentiometer, R_5, furnishes bucking voltage to balance out the residual current in the meter for zero-setting adjustment, and also furnishes bleeder current of about 1 ma. through the cathode resistor for initial bias. If desired, R_4 may also be made variable to adjust the maximum scale reading, but with a little experimentation a fixed resistor of the right value can be found. The 1-megohm grid input control, R_3, may be calibrated for use as a voltage divider to increase the voltage range. It also serves the purpose of "zero-ohms adjuster." The voltage-divider resistors were chosen arbitrarily so that no calibration chart or graph is needed for the d.c. and "high-ohm" ranges, since the readings can be obtained by applying a multiplying factor to the regular volt-ohmmeter reading. The d.c. scale is practically linear, so the error introduced will be negligible for ordinary testing purposes. However, the a.c. scale resembles a square-law curve,

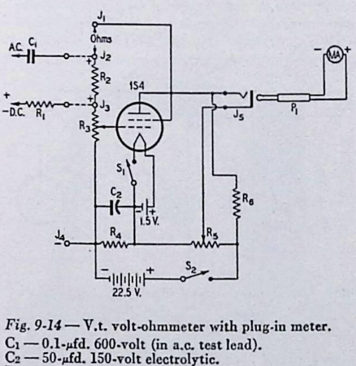


Fig. 9-14 — V.t. volt-ohmmeter with plug-in meter.

C_1 — 0.1-μfd. 600-volt (in a.c. test lead).
C_2 — 50-μfd. 150-volt electrolytic.
R_1 — 0.33 megohm (in d.c. test lead).
R_2 — 15 megohms.
R_3 — 1-megohm volume control.
R_4 — 2000 ohms.
R_5 — 20,000-ohm potentiometer.
R_6 — 12,500 ohms.
J_1, J_2, J_3, J_4 — Tip jacks.
J_5 — 'Phone jack.
MA — 200 microamperes.
P_1 — 'Phone plug for meter.

so a calibration chart should be drawn utilizing any reasonably-accurate calibrated source of variable voltage that may be available.

In the meter described the full-scale sensitivity on a.c. is about 2.1 volts and on d.c. 1.125 volts, which is raised to 1.5 volts by the isolating resistor in the test lead and multiplied to approximately 18 volts by the 15-megohm resistor. The 1-megohm potentiometer can be used to multiply the maximum input up to about 300 volts on the high range. Resistances up to about 1000 megohms may be measured with a fair degree of accuracy. No low ranges are provided, since most existing instruments measure up to 1 megohm or so. If the meter used is not marked with an ohms scale, a chart may be made by testing several resistors having known values of resistance or by using the following formula:

$R_X \times R \frac{(I_M - 1)}{I}$, where R_X is the unknown resistance indication,

R = initial resistance in circuit,

I_M = full-scale current reading,

I = current reading with unknown resistance across "ohms" terminals.

If a 1-ma. meter is used the plate voltage should be increased to 45 or 67.5 volts and the bias resistor adjusted for proper operation.

— *Roy McCarthy*

MODULATING THE TEST OSCILLATOR

A simple way to add modulation to the r.f. test oscillator is shown in Fig. 9-15. In this circuit the primary of a small interstage audio transformer, T, serves as a Heising modulation choke and a feed-back winding for a simple audio oscillator. Dual triodes such as the 6SN7 are ideal for the purpose, and any type of oscillator could be used instead of the series feed-back type shown. If a Clapp or an ECO is used as the r.f. oscillator, tubes with separate cathodes must be used.

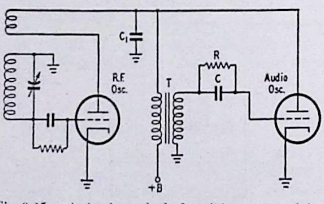


Fig. 9-15 — A simple method of applying tone modulation to the r.f. test oscillator. An old interstage audio transformer is used as combined Heising modulation choke and feed-back winding.

The tone may be changed by adjustment of the grid leak, R, and the condenser, C, in the audio-oscillator section of the tube. Suitable values in most instances will be 1 megohm for the resistor and 220 $\mu\mu$fd. for the condenser. C_1 should be 0.001 μfd. or less to avoid by-passing the audio frequencies.

— *Clifford Bader, W3NNL*

CHECKING THE FREQUENCY OF CRYSTAL BLANKS

Several ingenious methods have been suggested for getting rough checks on the frequency of a crystal blank during the grinding process, but none of them seems to be quite as simple as this:

Take a flat sheet of aluminum or copper about six inches square, and connect it to your receiver antenna post by a short lead. Place the plate glass on which the grinding is being done over this sheet. You can tune in the crystal frequency on the receiver by the scratches you hear as the crystal is being ground. You can then follow the scratching noise along the dial as you grind. When nearing the frequency you desire, the regular methods of crystal checking must be used, but up to this point the scratches will tell you what you want to know. This procedure saves the time usually required to wash, rinse and dry the crystal blank, replace it in a suitable holder, and fire up the oscillator stage each time you want a rough frequency check to show just how far you still have to go.

— *Elmer A. Gunther, WØACC*

EXTENDING THE RANGE OF THE C-R-L BRIDGE TO 10 MEGOHMS

The usefulness of the impedance bridge described in the July, 1944, issue of *QST*[1] can be increased by extending its range to 10 megohms. All that is required is the addition of another position to the multiplier switch and a simple

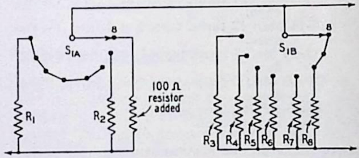


Fig. 9-16 — Modification required for extending the range of the *C-R-L* bridge to 10 megohms. The original diagram appeared in *QST* for July, 1944.

wiring change as shown in Fig. 9-16. Although a 7-position switch was specified in the parts list in this article, in most instances a standard 11-position switch was probably used. Move the stop on the switch over so that it covers 8 positions instead of the original 7. Connect a jumper between Positions 7 and 8, so that the 0.1-megohm resistor R_8 is brought in when the switch is set to Position 6, 7, or 8. Insert a 100-ohm resistor between Position 8 and the common terminal on the other gang of the switch. With this simple change, when the multiplier switch is set to Position 8, the *C-R-L* dial reading is multiplied by 100,000, producing a full-scale reading of 10 megohms.

— *Athan Cosmas, W2PKD*

[1] "An Inexpensive Impedance Bridge," Cosmas, *QST*, July, 1944.

10. Hints and Kinks . . . for the Shack

CONVENIENT JUNCTION BOX

The compact unit shown in Fig. 10-1 was patterned after a commercially-built unit, designed to provide a convenient a.c.-line outlet box for use in test set-ups requiring the application of power to several units at one time. It cuts down on the amount of "haywire" usually required in such cases, and eliminates the usual problem of "Where the heck am I gonna plug *this* in?"

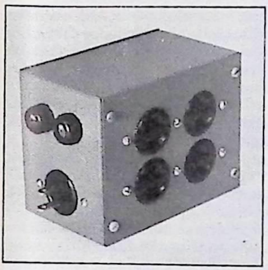


Fig. 10-1 — Here's one way of solving the problem of not having sufficient a.c. outlets in the shack. Eight a.c. receptacles are mounted on a 3 × 4 × 5-inch utility box, along with line fuses and an input connector.

Eight standard a.c. receptacles are mounted on the sides of a 3 × 4 × 5-inch utility box. A male a.c. plug and two fuse-holders are mounted on one end of the box. The wiring arrangement is shown in Fig. 10-2. It is suggested that the fuses be rated a little below the rating of the fuse in the house-wiring circuit that is used to supply the box. In this way, if a fuse blows, it will be the one in the box before the one down in the cellar!

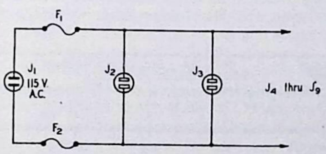


Fig. 10-2 — The output receptacles are wired in parallel across the input jack. J_1 is a standard male a.c. plug, while J_2 through J_9 are panel-mounting a.c. receptacles.

Variations on this scheme will suggest themselves, and if desired, toggle switches may be mounted near each receptacle to give control of the individual circuits within the box.

— *C. Vernon Chambers, W1JEQ*

INDIRECTLY-LIGHTED BEAM INDICATOR

The attractive beam indicating device shown in Figs. 10-3 and 10-4 is both inexpensive and easy to build. A great-circle map, centered on a city near your own, is framed and mounted in front of two 15-watt lamp bulbs. A Selsyn motor, coupled to its mate at the antenna, is mounted between the bulbs, with its shaft extending through a small hole at the center of the map. A transparent compass card is placed over the

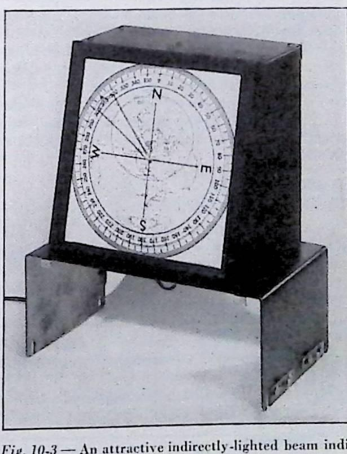


Fig. 10-3 — An attractive indirectly-lighted beam indicating device.

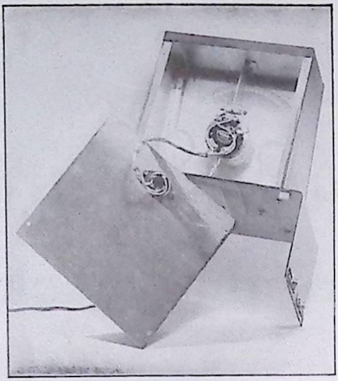


Fig. 10-4 — Rear view of the beam indicator, showing method of mounting the Selsyn and the lamps. Control wires are cabled and run out of the box through a 5-prong terminal mounted on the rear cover-plate.

map, and the entire assembly is firmly supported within a sloping-front box as shown in the photographs.

As an added refinement, the map itself may be "plasticized" for a small additional cost. Hams in larger cities should have no trouble in finding someone who can do this work. The result is similar to the plastic-cased discharge papers, oil-company courtesy cards, etc., that most of us have seen. If it is not possible to have the map plasticized, it may be mounted on a sheet of clear cellulose acetate.

The pointer should be made of lightweight material so that its own weight will not cause it to shift position after the beam is aimed in a given direction. If necessary, a double-ended pointer can be used, trimming the end to produce a true balance that will permit it to stay put, without putting a load on the Selsyn motor.

The unit shown was built by Julius Galin, W1LOP, of the Headquarters laboratory, from ideas suggested by himself and Jack Matthews, W3DPA.

A WORLD-TIME SLIDE RULE

A time indicator is a useful and interesting gadget to have around the shack, especially when working DX. With it you can tell what time it is at the station you are contacting or at any other point on the globe. It also provides a rapid means of converting local time into some common reference time, such as GCT. There are several good calculators on the market, but the one shown in the sketch is simple enough so that any ham can make one. The few materials required are easy to obtain and the work involved takes only a matter of an hour or so.

Scales, such as the set shown in Fig. 10-5, are glued over the regular scales of an ordinary cheap slide rule of the type selling for a quarter or half a dollar. As an alternative, a reasonable substitute can be made from strips of cardboard. Use a wide strip for the back. Then glue on the narrower strips carrying the upper and lower scales. This will leave a path for the sliding strip between the upper and lower scales. A substitute for the glass slide can be made by cementing a piece of celluloid to a couple of small pieces of wood or bakelite.

The scales may be drawn up with India ink by hand or perhaps more conveniently with a typewriter. If the carriage of the typewriter is not long enough for the complete length, each scale may be typed in halves and the sections glued together. The calibration marks are made with the apostrophe mark, the typewriter providing automatic equal spacing. The time marks represent 15-minute intervals, while the meridian marks represent 15-degree time zones. The top and bottom scales are the same except that the upper one is calibrated in city locations while the lower one is calibrated in degrees east and west of Greenwich. The city marks are made opposite their corresponding time meridians, which can be taken from a globe or map.

Operation of the time slide rule is quite simple. If you wish to determine the time at some DX station you may be working, set the slide so that your clock reading is opposite your location on the top scale or your time meridian on the bottom scale, reading the time at the DX station under the name of the town on the upper scale or over the time meridian of the DX station on the lower scale. Referring to Fig. 10-5, with the slide set as shown, when it is 6 A.M. in New York it is 3 A.M. in San Francisco, 1 P.M. in Moscow and 7 P.M. in Manila. To convert to GCT use the same procedure, reading GCT on the upper slide scale above 0 degrees on the bottom scale. Thus, as Fig. 10-5 shows, 6 A.M. New York time is 1100 GCT; 7 P.M. Manila time also is 1100 GCT.

In setting the slide to your local time, the slide usually will extend either to right or left so that part of the fixed scales will not be covered. For instance, with the slide set as shown in Fig. 10-5,

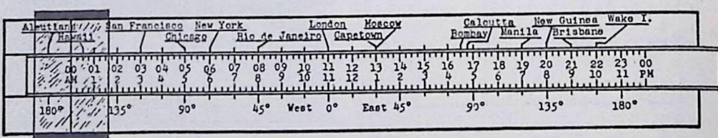


Fig. 10-5 — World-time calculator made from an inexpensive slide rule.

the time in the Aleutians is not shown. In cases like this, slide the glass indicator over the "00" mark on the slide after it has been set to your local time. Then slide the other "00" mark at the opposite end of the slide under the hairline, thus covering the desired DX point. The changing of "00s" results in the slide extending to the left, and times indicated are in the day preceding the local day; in other words, "yesterday." When it results in the slide extending to the right, the times indicated are in the day following the local day, or "tomorrow." Whenever it is not necessary to change "00s" to cover the desired DX point, the day at the DX point is the same as locally.

As an example, suppose it is 2 A.M. in New York and we want to find out what time it is in Hawaii. When the slide is set with 2 A.M. under the "New York" mark (or over the 75-degree mark), the left-hand "00" will come over the 105-degree W. mark. The glass slide is set at this point to hold the place while the slide is reset with the right-hand "00" over 105 degrees W. The time of 8:30 P.M. now will be found under "Hawaii." Since the slide is extending to the left, it means that it is 8:30 P.M. of the preceding day. Therefore if it is 2 A.M. Tuesday in New York, it is 8:30 P.M. Monday in Hawaii.

As a second example, if it is 6 P.M. in Chicago, what time is it in Manila? Setting 6 P.M. under "Chicago" brings the right-hand "00" over the 0-degree mark on the bottom scale, leaving "Manila" uncovered. Shifting the left-hand "00" over the 0-degree mark shows that it is 8 A.M. in Manila. Since the slide is extending to the right, it means that Manila is in the next day. If it is 6 P.M. Tuesday in Chicago, it is 8 A.M. Wednesday in Manila.

In general, the time for any given location is taken as the sun time at the nearest 15-degree meridian. For example, EST is 75th meridian time, PST is 120th meridian time, etc. Throughout the world, however, there are many local exceptions to this rule. Hawaii, for instance, runs on a time differing from the nearest time meridian by 30 minutes. Bombay also runs on a 30-minute difference, while Calcutta's time is 6 minutes ahead of 90th meridian (east) time. There is a 20-minute difference in Singapore's time. When these exceptions occur, the time marks for the upper scale will, of course, come in between the even hour marks.

— *W. J. Christian*

AVOIDING FROZEN FISTS

Few shacks are adequately heated, and though the operator may be comfortably dressed, his fingers may still become too numb and sluggish for deft keying. A mitten is hardly practical.

The solution is an ordinary gooseneck desk lamp, bent close down directly above the hand. A 40- or 60-watt bulb at a distance of six to eight inches soon spreads a pleasant warmth from wrist to fingertips. The lamp will give a good light for log and note pad besides keeping your fist from "freezing."

— *A. F. Scotten, W6ZMZ*

MASTER CONTROL SWITCH

The system of operating control installed here may interest others contemplating the use of low power transmitters with a common transmit-receive antenna. A bat-handled s.p.s.t. toggle switch located in a convenient position (near transmitting key or where the left hand can manipulate it easily) does the trick.

This master toggle switch controls three relays, either 6- or 115-volt types, as follows:

Relay No. 1 — d.p.d.t. (antenna change-over).
Relay No. 2 — s.p.s.t. normally closed (receiver B-plus switch)
Relay No. 3 — d.p.d.t. (headphones).

Connect so that in transmit position,

Relay No. 1 — connects antenna to transmitter.
Relay No. 2 — opens B-plus to receiver.
Relay No. 3 — connects headphones to monitor.

Then, in receive position,

Relay No. 1 — connects antenna to receiver.
Relay No. 2 — closes B-plus to receiver.
Relay No. 3 — connects headphones to receiver.

This affords a quick and efficient change-over, little short of break-in operating.

— *Harold W. Ryall, W1NKW*

DE LUXE CALL-LETTER PLATES FOR THE NOBILE "SHACK"

A new type of sign material called "Scotchlite" is now available, and is widely used on highway signs. This material reflects light and makes an excellent call-letter plate for a ham's car.

"Scotchlite" is a sheet of waterproof flexible material covered with ground glass. The call letters are stenciled on, using thick paint pigment from the bottom of the can so that the paint will not run. Most sign shops now carry this material. If you have a sign made up, be sure to take along a sheet of tin or aluminum to use as the backing plate so that the sign maker can fasten the "Scotchlite" to it with the special waterproof glue that is provided. A variety of colors is available. I use a similar sign (with the name of my town on it) when hitchhiking back from club meetings late at night.

— *George C. Robinson*

AN OPERATING CONSOLE FOR THE AMATEUR STATION

Mounting equipment in a console desk was suggested by looking over many commercial installations which tend toward this arrangement. Such a console was built at W9EYN several years ago and has been a source of great satisfaction. Nearly every visitor to the shack contemplates construction of something similar when they realize all the advantages possible. The design makes a hit with the XYL also, since most of the unsightly equipment that usually clutters up the operating table is neatly mounted out of sight. An entire station may be built into such a console, depending on size and how much auxiliary

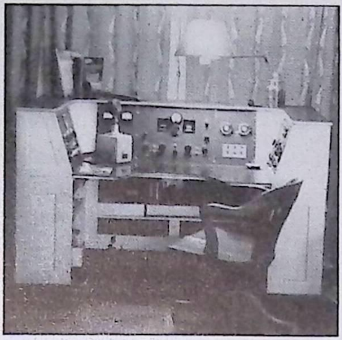


Fig. 10-6 — Front view of the operating console. The panels beneath the writing shelf have been removed to show the space available for power supplies and other units not requiring adjustment.

equipment it is desired to locate at the operating position. In our case, it was decided to mount only the receiver, exciter, speech amplifier and monitor in the desk — with, of course, the necessary power and bandswitching controls for a remotely-located transmitter.

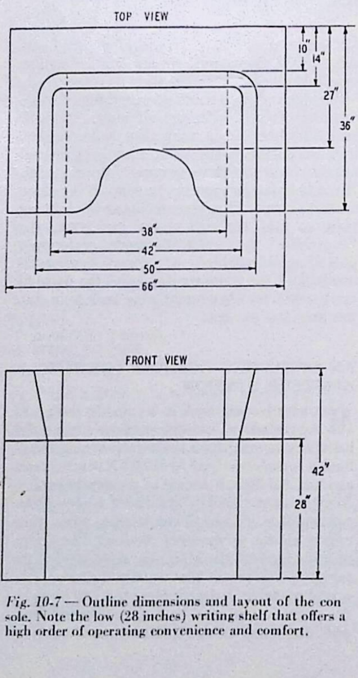


Fig. 10-7 — Outline dimensions and layout of the console. Note the low (28 inches) writing shelf that offers a high order of operating convenience and comfort.

There are many possible arrangements for equipment. It would seem logical to mount the receiver in the center panel with sufficient space remaining for power controls, monitor, modulation indicator, and similar accessories. The VFO may be located on one side with speech-input control and speech amplifier on the opposite. There is ample space for power supplies, as well as other units not requiring direct control, in the rear lower section of the desk. Lower side cabinets have room for logbooks, *QST* files, and other station necessities.

As to construction, it is suggested that the console be made in detachable sections. It becomes a rather large piece of furniture and difficulty might be experienced if it had to be moved. In the desk there are six handy sections. Three lower units make up a U angle which is bridged by the operating table top. Three upper sections mount the panel equipment. The sections may be made up in the form of open framework,

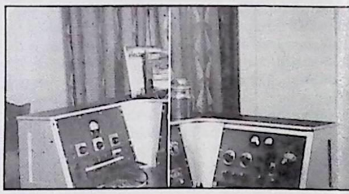


Fig. 10-8 — Close-ups of the side panels of the console. The controls for the speech amplifier and the audio circuits are located on the left panel. The right-hand panel contains the VFO and the exciter.

with spaces not filled by equipment paneled in with plywood or other type material. Angle-iron strips can be used to mount the panel-supported equipment. Each side section should have removable cabinet-type doors to allow access in rear. The back of the console might be left open. A shelf across the back lower section affords plenty of space for power supplies.

Complete constructional details are not given here, but Fig. 10-7 supplies suggested measurements. The operating table top is lower than usual. This allows a more comfortable position for the arms and shoulders. A semicircular cut-out is made in the front of the table to allow the operator to reach controls conveniently, and the position is excellent for a key or bug located at one side. The suggested dimensions allow the mounting of two 19-inch panels in the center, and one 19-inch panel to the right or left.

If good wood is used the desk might be finished in natural grain and a really nice piece of furniture constructed. Our desk got a coat of flat paint which has been since regretted. To trim and finish the project, cover the table top and upper shelf with battleship linoleum, securing the edges with metal strip available for the purpose.

— *Joe Rohrer, WØEYN*

NEON-BULB PROTECTOR

DOZENS of neon bulbs are tossed into the ash can because they rolled off the operating desk and smashed on the floor. A simple way to avoid this is to wind a piece of insulated hook-up wire around the base once or twice, give it a twist, and cut off the ends, leaving about an inch of each end of the wire sticking out. These short tabs will prevent the bulb from rolling, and will keep it on the desk where it belongs.

— *H. A. Fanckboner, W9BPS*

A RACK-TOP OPERATING TABLE

HERE at W2OLU, the "shack" is located in the living room, part of a three-room apartment. Something definitely better than the desk, already overcrowded, was needed for an operating position. In the process of design, it was decided to incorporate some simple structure that would enable the radio gear to be held securely in a rack, or on shelves, over the table. How this was done, at a total cost of only ten dollars, is the theme of this article.

The combined table and rack finally built gives a man room enough to pound a key and still rest his arm on the table top — it's 36 inches wide and 30 inches deep. Over this there is space for six standard-size relay-rack chassis, 12 × 17 inches. While the whole affair is home-constructed and is hardly a "glamor" job (cost precluded this), it is definitely presentable — sufficiently so that the XYL did not object to having it in the living room. Incidentally, the whole job was completed in the aforementioned three-room apartment, over the week end, without disturbing any of the other tenants. (Cliff-dwellers, please take note.)

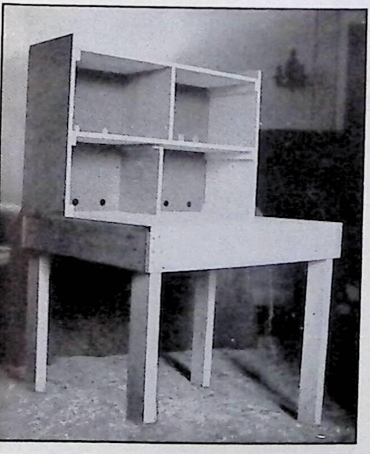


Fig. 10-9 — The finished rack-top operating position, ready for occupancy.

List of Materials

2 fir plywood panels, 2 ft. × 4 ft. × 5/8 in.	$ 4.80
2 pcs. clear fir, 2 in. × 4 in. × 6 ft.	1.92
2 pcs. clear fir, 1 in. × 5 in. × 6 ft.	1.50
1 pc. pine, 5/8 in. × 6 in. × 4 ft.	.75
1 tempered Presdwood panel, 2 ft. × 3 ft. × 1/8 in.	.66
4 doz. No. 8 flat-head wood screws, 1 1/2 in. long (for table top and shelf tops)	.20
6 doz. No. 8 round-head wood screws, 1 1/4 in. long	.30
1 box 3/8-in. "wiggle" nails	.10
5 doz. small screws, 1/2 in. long (or 1/2-in. brads) (for fastening Presdwood panel)	.20
Total	$10.43

The key to the whole construction is the use of standard-size plywood panels. This ham application of the module principle definitely pays off in this case. It cuts down on labor and construction time, and there is no waste involved. Every piece of wood paid for is utilized 100 per cent. The sketch shown in Fig. 10-10 will enable any amateur to cut the lumber to size after obtaining

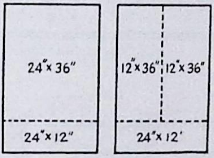


Fig. 10-10 — Two 2 × 4-foot plywood panels are cut as shown in this sketch to form the rack.

it from the local lumber yard. I cut all the pieces to size in the bathroom, and sanded them down; only when ready for the final assembly did it become necessary to move into the living room.

Standard-size 5/8-inch 5-ply fir plywood panels, 2 × 4 feet, were utilized to make up the table top, the sides and the shelves of the rack structure. In order to add an extra six inches of depth to the operating table, without involving waste or additional expense, a piece of pine, 6 inches wide and 5/8 inch thick, was joined to the 24 × 36-inch piece of fir plywood, using corrugated fasteners or "wiggle nails" as they are sometimes called. I used a dozen, spaced every 3 inches, to tie the two pieces of wood securely together. This brings the top up to 30 × 36 inches in size. Around the edge, under the top, is a rail made from so-called 1 × 5-inch board (actually 4 1/2 inches wide and 3/4 inch thick). One six-foot length was cut exactly in two, at 36 inches. This provides the front and back rails. Allowing 3/4 inch at each end, the side-rail pieces were cut 1 1/2 inches short of 30 inches, or 28 1/2 inches. Flat-head wood screws, 1 1/2 inches long, are screwed through the table top to hold the rail in place. This gives a smooth working surface. Three inches in from each corner, and

spaced six inches apart, a total of 22 screws holds the table top to the rail, five in each side and six along the front and the rear. This makes the whole assembly quite rigid.

To make the table top 30 inches from the floor, four legs, 29½ inches long, were cut from finished 2 × 4-inch stock. They are securely held to the rails by six wood screws, using three on each surface. The sketch of Fig. 10-11 should make this clear. The two rails are also butt-joined by three wood screws where they meet. Staggering the wood screws in the corners makes for greater strength, and there is less chance of splitting the wood. The use of screws makes for more work than nailing, it is admitted, but the resulting job is exceptionally rigid, without a trace of shimmy even though the legs are not crossbraced. Furthermore, the legs can be removed for transporting and a loose screw can be tightened while a nail can't — a point worth considering in steam-heated buildings, for furniture has a bad tendency to dry out, especially in the winter months.

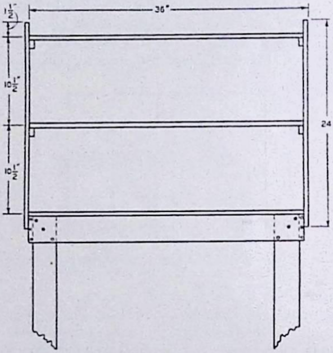


Fig. 10-11 — Sketch showing dimensions of operating table and method of assembly.

The two 12 × 24-inch pieces are used for uprights in the superstructure and the two 12 × 36-inch pieces form the shelves. The 12-inch remnant from the 6-inch pine board is sawed into four pieces 1½ × 12 inches. These are used to support the shelves between the uprights. I used 10½-inch spacing between the shelves, and it worked out fine, but this could be modified to suit the builder.

The whole rack structure was a trifle shaky when mounted on top of the table, but adding a sheet of ⅛-inch Presdwood to the back really tied things down! This sheet overlaps the rear of the table to permit its being fastened to the rear rail as well as to the shelves and the uprights. This brings the top edge of the sheet about one inch above the top shelf of the rack. This works out fine in practice since it is high enough to hold the top chassis in place and yet does not interfere with leads out of the rear. In the back of the lower spaces, holes were drilled where necessary to pass plugs and cables through the Presdwood back. As the table-rack is being used here, it houses four 11 × 17-inch chassis, plus a homemade superhet on the left of the table top, with keys, control switches and Variac on the right-hand end of the table. However, it could be utilized to hold up six 12 × 17-inch chassis, as it stands, or modified to suit almost any desired arrangement.

Because the table-and-rack is in the living room, the whole affair was given a coat of clear lacquer, which ran up the cost another 75 cents. The material shown in the list was bought in the suburban New York area. I doubt if prices could be much higher in any other locality; but this still amounts to the best ten dollars I have ever invested in ham radio.

— *Neil A. Johnson, W2OLU*

AN INEXPENSIVE TRANSMITTER CONSOLE

In designing the transmitter cabinet shown, our objective was a self-contained transmitter with a high degree of safety that would be readily accessible for adjustment or repair. It was to be of lightweight construction and, above all, pleasing in appearance. The usual amateur requirements of ease of construction and low cost were also important factors.

A piece of 20-gauge cold-rolled steel 44 by 72 inches was laid out as shown in Fig. 10-14. Notches and cuts were made with a pair of tin snips, and the corners were bent on a local tinsmith's sheet-metal brake. The round front corners were made by making a series of very slight bends within a predetermined area. It would be well to practise making the round corners on a piece of similar metal before starting the corners

Fig. 10-12 — The homemade transmitter console at W8MGS rivals any commercial product in appearance and convenience. The meters, set behind a Lucite panel and using homemade scales, are indirectly lighted.

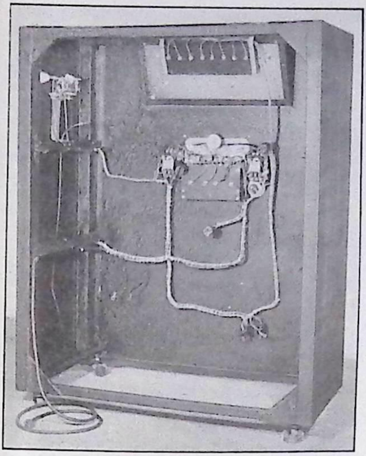


Fig. 10-13 — A rear view of the cabinet with the chassis removed, showing the antenna relay on the left-hand wall and the plug-in power cables.

of the cabinet. Channels, corner braces, top strips and top-corner gussets should also be cut and formed as shown.

All parts were spot-welded together into one solid unit. First, however, in order to save the welder's time, all parts were riveted together with very small tinsmith rivets, in just enough places to maintain the correct shape of the cabinet. The weld spots were spaced approximately one to two inches, a procedure that gave a very rigid final product. All outside joints were filled with a 95-5 hard solder. This solder melts at 400° F. and, since the steel conducts away the heat fairly well, a husky soldering iron must be used. The acid flux was rinsed off with plenty of clean water to prevent subsequent corrosion. The excess solder from the corners and joints was removed with a file and then smoothed with steel wool and emery cloth, making the unit look as if it were only one piece of steel.

After the cabinet was completed, the lid was cut to fit and the opening was cut out. The lid fits flush within the space provided for it, and small ¼-inch reinforcing channels were riveted and soldered on the underside to stiffen it. Hinges were riveted and soldered at the back-underneath side of the lid, and provision was made for bolting the hinges to the rear channel so that the lid could be removed at any time if it were necessary.

The cabinet was painted by a local instrument concern which had facilities for baking crackle finishes. However, if a crackle is not available or desirable, several coats of either grey or black brushed enamel would look very attractive.

To dress up the cabinet, a few strips of stainless-steel trim were mounted on the front and an aluminum grille mounted on the lid. The grille was made from a sheet of aluminum cut into strips approximately ¾ inch longer than the ventilating opening. Then slots were cut in the ends of the strips just long enough to permit the strips to fit in the opening. Spacers and long brass rods threaded on the ends were used to keep the polished and lacquered aluminum strips in place. The front of the meter case is made of polystyrene (or lucite). The meter scales are illuminated indirectly by pilot bulbs which are placed between the meters.

The tuning wheels and knobs connect to the tuning condensers, selector switches and other controls by flexible cables. The various lengths that were necessary were cut from automobile radio control cable. This can be done easily and back-lash from loosened turns can be avoided if the cable is first tinned in the vicinity of the cut. Then a ¼-inch copper tube about one inch long is slipped down over the point to be cut and the tube filled with solder. The tube is then cut in the center and serves as a short shaft. The final tank condenser was connected by two insulated universal joints because the angle between its shaft and the tuning wheel shaft was too sharp for flexible cable.

For safety to the operator an interlock switch is used under the lid to cut off all power when the lid is raised, and a protective circuit with two overload relays and one master holding relay is used to protect the high-voltage power supply in

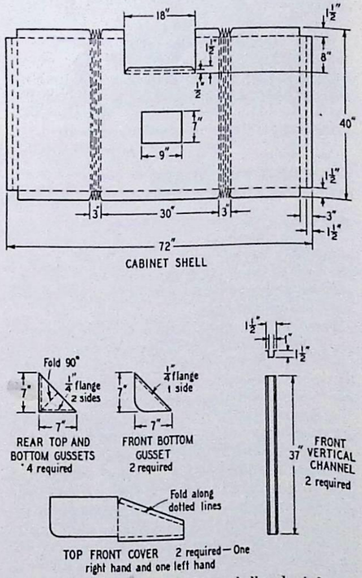


Fig. 10-14 — Details of the cabinet shell and reinforcing members. The material is 20-gauge cold-rolled steel.

case of an overload or accidental short-circuit. Relays for antenna change-over and in the low-voltage transformer secondary center taps are controlled by a single "send-receive" switch.

The transmitter and power-supply chassis were cut and formed from 18-gauge steel. Rivets were used to fasten the flanges in the corners and these joints were also filled with solder. The chassis were cadmium plated and then buffed to get a mirror finish. All three chassis are supported at the ends by small ¾-inch angles which are bolted to the rear flanges and front vertical channels of the cabinet.

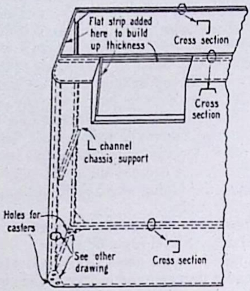


Fig. 10-15 — Assembly details of the transmitter console. The pieces are assembled with small rivets and then spot-welded.

All wiring from meters, switches and relays is cabled and terminated at the chassis in 6-prong sockets and plugs. This permits removal of any chassis from the cabinet to the workbench and, by the use of an extension cable, still allows the removed unit to be energized and tested.

— *S. E. Garber, W8MGS*

PLANNING THE SHACK FOR APPEARANCE AND CONVENIENCE

Not every ham has the chance to build his own shack (known as "home" to the wife and parasitics), but when he does he wants to make the most of the opportunity. Here are a few suggestions and experiences gained from doing such a job a short time ago.

Put down on paper every possible improvement you can figure on before you ever start to build and discuss them with your contractor before you build, or you may find that your ideas cost more money than you can afford.

A ground system is essential to any properly-installed radio station, so a little thought should be given this before work is actually started. In my case, a couple of hundred feet of one-inch wide copper ribbon was obtained, and one strap was put in lengthwise and two crosswise in the excavation, with the ends being brought up to the top of the foundation, and *outside* of the foundation. These ends provide places to tie on any additional ground network which may be put in later. Straps should be soldered on inside the foundation and brought up for connection in the radio room and to the work bench. A network of heavy copper wire can be used equally well, if no ribbon is available. After the house is built, all pipes and metal work can be bonded together and connected to the same ground strap.

The electrical installation would probably give the amateur his best chance to improve the radio room, as compared to the average house-wiring job. In my case, a Cutler-Hammer overload-breaker center provided circuit control for four 15-, one 24- and one 35-ampere circuits. The last two provided for three-wire services and, since I did not plan to use an electric stove, the 35-ampere circuit went to the ham shack, by way of three No. 8 wires. A pair of twist-lock receptacles provide two 110-volt circuits, one on each side of the line, while 220 volts is available from the hot wires in each of these two circuits. The twist-lock receptacles have plugs which are inserted and then rotated a portion of a turn to prevent their working out with heavy cables attached — and perhaps interrupting a QSO. Ordinary home outlets provide connection for receiver supply, desk lamp, electric clock and other equipment requiring a small amount of current. A single extension cord comes from the nearest outlet to a five-gang outlet box located high up inside the knee hole of the desk, making it unnecessary to run a number of cords from desk to wall. A store-type indirect-lighting fixture using a 200-watt bulb gives adequate light for everything except reading.

Receiving antennas for the broadcast receivers in the house can be installed in the walls when the house is being built, and come out at the special antenna outlet plates available. This will make it unnecessary to run any wires outside except the regular transmitting antenna. Connections to the transmitting antenna come through the wall by way of Navy-type Pyrex bowls and heavy brass rods.

Built-in shelves and cupboards would be very handy in a shack, and every effort should be made to provide room for *QST*s, catalogs, old logs and many other items which clutter up an operating desk. Large panels of Celotex can be screwed to the wall (assuming the room is not finished in Celotex) to take maps and QSL cards. An extra-wide door served me very well when I discovered that my new operating desk had a minimum dimension of 30½ inches. Linoleum on the floor would give an opportunity for insertion of an ARRL diamond in the center, and commercial cut-outs of compass directions are also available. Linoleum must be waxed and polished for wear and appearance, however, and shoes and furniture leave marks hard to polish out.

Trimming for the radio room can include aluminum venetian blinds instead of curtains and, if your pocketbook can stand it, chrome-steel furniture. Strip carpeting can be used instead of a full-size rug — probably you won't be shifting your furniture every few days as your wife does!

— *Eugene A. Hubbell, W9ERU*

11. Hints and Kinks . . .
for Converting Surplus

REVAMPING THE BC-348-Q RECEIVER

The BC-348-Q is a receiver which has attained widespread use and acclaim by the amateur fraternity. It lends itself well to changes which make it more efficient from the amateur's standpoint. The purpose of this article is to describe some of the simple changes made in a receiver of the "Q" series (110-volt a.c. adaptation) and to point out other more difficult changes which can be made if the owner so desires.

In order to change the circuit the physical layout of the set had to be altered slightly. One making these changes can suit his own preference and station requirements in the location of switches, jacks and plugs.

Antenna Terminals

Beginning with the antenna terminals and working through the set to the output transformer, the first addition was an auxiliary set of "Ant.-Gnd." terminals placed at the rear of the chassis. A terminal strip was bolted to the frame of the set at the rear, as shown in the photograph of Fig. 11-8, and a wire was brought from the "Ant." terminal on the panel along the lateral side of the antenna unit (*190*) to it. The ground connection was made directly to the chassis via a small lug under the bolt holding the terminal strip. A 1$\frac{3}{16}$-inch hole was cut in the cabinet to allow access to the new terminals (Fig. 11-2).

At this point it might be mentioned that if one desires to use balanced input on any band with this receiver he can isolate the antenna-coil ground return and bring it out to a third terminal at the rear. It is also necessary to clip condenser *41*. This change necessitates removing antenna unit *190*, a difficult task in itself, and subsequently realigning the r.f. end.

First R.F. Stage

In the original circuit the first r.f. stage is connected to operate as a triode. Increased r.f. gain can be obtained by changing this stage to pentode

Fig. 11-1 — A view of the panel of the revamped BC-348-Q. An S-meter has been installed at the upper right. Of the three toggle switches in the lower left-hand corner, the left-hand one is for send-receive, the upper right controls the a.v.c., and the lower one turns on the noise limiter.

operation. At the installation being described, the first r.f. stage was also removed from the r.f. gain-control circuit. The circuit for these changes appears in Fig. 11-3. As seen in the diagram, G_3 is connected via the shield to ground as in the original. The jumper between G_2 and the plate is removed and a 0.01-μfd. by-pass condenser is placed between G_2 and ground. A 70,000-ohm

INDEX TO CHAPTER ELEVEN

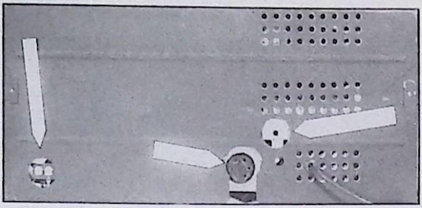


Fig. 11-2 — A rear view of the BC-348-Q with the case replaced, showing clearance holes cut in the case.

resistor is inserted between G_2 and a point on the lug side of the 15,000-ohm resistor, *99-3*. It is important that this plus lead connect to the B+ bus below resistor *99-3*. Condenser *65* is shunted to ground by a 250-ohm ¼-watt resistor. The lead between the cathode of the first r.f. stage and G_3 of the second r.f. stage was removed, allowing the first r.f. stage to operate "wide open."

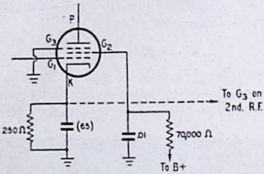


Fig. 11-3 — The modified first r.f. stage. The lead represented by the dotted line is removed, and the cathode returned to ground through the 250-ohm resistor. [See Fig. 11-9 and later text for an alternative modification of this stage. — *Ed.*]

Gain Controls

Continuing through the circuit, the next change was the incorporation of separate r.f. and a.f. gain controls. The "AVC-OFF-MVC" switch, *169*, was removed and in its place was inserted a s.p.s.t. switch (S_1 in Fig. 11-6) to control the a.v.c. network to be considered later. Circuits for r.f. gain, a.f. gain, and a.v.c. are given in Figs. 11-4, 11-5 and 11-6.

The dual potentiometer, *110*, was removed and in its place was substituted a 0.35-megohm potentiometer with switch. This unit controls the a.f. gain and the 110-volt supply to the primary winding of the power transformer. The leads to the former volume control were not disturbed other than to attach them to the new potentiometer-switch unit. The two potentiometers in the dual control can be separated readily, allowing the 20,000-ohm section to be used as a separate r.f. gain control. This particular control has a special taper so it is advisable to use it. It was mounted on the panel just to the left of the crystal switch. Leads were carried below through holes drilled in terminal board *198*, located below crystal unit *160*. It is important that the 100-ohm resistor, *107-3*, be removed from the r.f. gain-control circuit and utilized in the a.v.c. circuit alone.

The a.v.c. circuit is connected with a switch placed between ground and resistor *107-3*. This switch was mounted in the hole previously occupied by switch *169* and acts as the a.v.c. on-off switch. The circuit for the a.v.c. control is given in Fig. 11-6.

Noise Limiter

A noise-limiting circuit similar to that which has appeared in many issues of *QST* was inserted. The circuit for this is given in Fig. 11-5. Switching the network into the circuit produces very little reduction of volume. A switch was placed in a hole drilled in the panel just below what is now the a.v.c. on-off switch. The noise-limiter network could be permanently connected into the circuit without diminishing the efficiency of the receiver, if one doesn't want to bother with the switch.

When the crystal-filter network is switched into the circuit, the selectivity of the receiver is markedly increased but the gain of the receiver is diminished. Because of this some users might like an additional stage of audio. This was not added at this station, however.

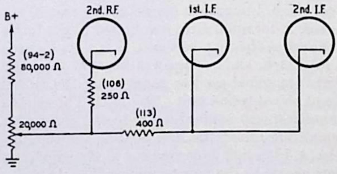


Fig. 11-4 — The gain-control circuit is revised by separating the tapered 20,000-ohm potentiometer from the combination control and connecting it as shown.

• There are two versions of the BC-348, both made to the same performance specifications but differing considerably in circuit design. One group is identified by the suffix letters J, N and Q, the other by the letters E, M, P, O, R and S. The conversion procedure presented in these pages for the BC-348-Q is applicable to the first group, that for the BC-348-O to the second group.

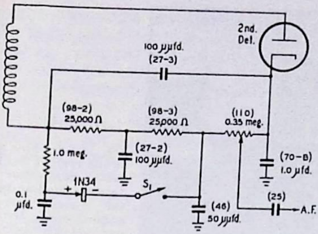


Fig. 11-5 — A shunt-type noise silencer is added to the second detector by revising the circuit slightly and adding a 1N34 crystal diode, a 1-megohm resistor, a switch and a 0.1-μfd. condenser.

Output Jack and Coupling

The output transformer *155a* has two output taps designated "high" and "low." The "high" tap has an impedance of approximately 4500 ohms to match a headset and the "low" tap has an impedance of 500 ohms to match a line. Some users who have not discovered that the resistance values given in the *Instruction Handbook* accompanying the receiver refer to d.c. resistance instead of impedance, will be pleasantly surprised at the increased gain which follows the incorporation of a 500-ohm-to-voice-coil transformer at the 'speaker end of the line. As shown in the photographs, a jack was mounted on the chassis at the rear adjacent to connector *SO-104* and a corresponding 1$\frac{3}{16}$-inch hole was cut in the cabinet. Condenser *61-8* was moved slightly toward the output transformer. This jack is used for 'speaker output and the "low" tap is connected to it. Another lead was run from the "high" tap to one of the jacks on the front panel and is reserved for headphone use. The upper headphone jack was removed and in its place a s.p.s.t. switch was inserted in the power-transformer high-voltage center tap for send-receive. There are provisions for a send-receive relay through Pins 2 and 6 in *SO-104*, but the screen circuit controlled by 2 and 6 was used for an S-meter, and as a result other provisions for send-receive relaying and switching are necessary.

S-Meter

The S-meter circuit is given in Fig. 11-7. The meter used was a 0–150 microammeter, although a higher-range one can be used, and it was mounted in the upper right-hand corner of the

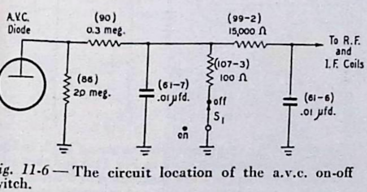


Fig. 11-6 — The circuit location of the a.v.c. on-off switch.

panel, as shown in the photograph. The circuit constants for the meter were found to be critical, but if those given are used one should experience no difficulty. It might be mentioned that in order to obtain a greater swing of the meter it is necessary to decrease the 0.15-megohm resistor and to decrease the swing this resistor is increased. When the r.f. gain is decreased the meter tends to go off scale to the right and when the c.w. oscillator is turned on it tends to go to the left. Because of this a separate switch could be placed at point *X* on the diagram.

The plug connector *SO-104* was removed from the set, and in its place a 6-prong socket was used. This was mounted in the end of an old i.f. can. The shield can was cut down to fit the available space and it made a very rigid support for the socket and also made it possible to mount the socket at the extreme rear edge of the chassis, using the same tapped holes and screws which were used with the original fitting. It was necessary to replace the original fitting, since no plug was available which would match *SO-104*. Termi-

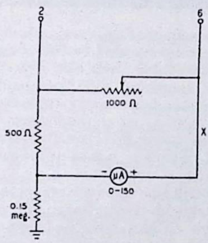


Fig. 11-7 — The S-meter circuit requires a 0–150 microammeter and three resistors. For greater meter swing, the 0.15-megohm resistor should be replaced by one of a lower value. If a higher-range meter is used, such as a 0–1 milliammeter, the 0.15-megohm resistor should be replaced by a resistor of lower value.

nals 1 and 5 were disregarded, since they were taken care of by the 'speaker jack already mentioned. The send-receive connections, paralleling the s.p.s.t. switch on the panel, were made to two of the socket terminals. In this way an external relay can be used with the send-receive switch on the panel remaining in the "off" position. This facilitates break-in operation. Terminals 2, 6 and 7 or 8 (ground) were connected to three of the other terminals and the three make up the point where the S-meter connects into the circuit. The 1000-ohm potentiometer was mounted on a small angle and the resistor network mounted on it. The meter leads were then carried forward to the meter position on the panel. In order to use a plug to fit the 6-prong socket it was necessary to enlarge the rectangular opening in the rear of the cabinet with a rat-tail file. The metal is very soft and is easily removed to the desired configuration. In order to mount this new plug arrangement, it was necessary to remove the shield which separated the original from the

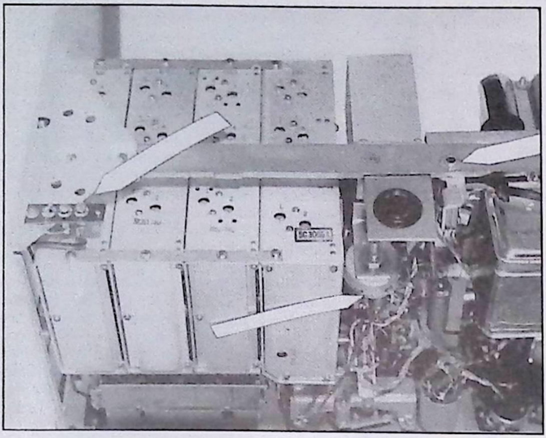


Fig. 11-8 — This view of the rear of the BC-348-Q shows how the antenna binding posts, the S-meter zero-set potentiometer, the output 'speaker jack and the 6-prong socket for connecting to an external send-receive switch are installed.

rear of the cabinet. The screws which held this shield in place were used to fill in the holes in the panel resulting from the removal of the nameplate. Removing this plate made the receiver take on a less military appearance. Black paint was used to cover the various unwanted markings on the panel. "Decal" titles now available could be used to complete the panel markings for the new controls.

Upon completion of all changes, the i.f. stages were peaked with the crystal in the circuit. The effectiveness of this receiver need not be described to those who already own it, for it makes a very satisfactory amateur instrument. The changes described can be made in a few hours at a minimum of expense. The author wishes to acknowledge his gratitude to W6FTU and W6SHK for the suggestions and help which they gave in the conversion of the receiver.

— *Dr. Paul M. Kersten, WØWIT*

—•••—

THE many inquiries concerning the changes made in my BC-348-Q as described in the above article make it seem worth while to supplement the original conversion procedure with a postscript covering further beneficial changes made since that time.

Beginning at the r.f. end and working back, the 0.002-μfd. mica condenser in the antenna lead (circuit designation *22*) was removed, as was also the 75-$\mu\mu$fd. unit (*41*) which parallels the antenna coils. Each can be reached by removing the bottom shield plate of the antenna-coil compartment. The "Antenna-Ground" terminals were removed from the panel and a small 100-$\mu\mu$fd. variable condenser was placed in the hole left from the "Antenna" terminal. This was wired between the antenna input and ground, thereby making it possible to tune the antenna coils for added gain.

In the first r.f. stage an 1852 was substituted for the 6SK7, with a remarkable improvement in signal-to-noise ratio. In the original article it was shown that the first r.f. tube was run "wide open" as a pentode instead of as a triode. In addition to changing the plate and screen resistors to allow the 1852 to operate at nearly rated voltages, it was removed from the a.v.c. circuit. This was accomplished by grounding the bottom end of the 1-megohm grid resistor (*87-1*) and removing the lead which previously connected it to *98-1* and *96-2*, 25,000- and 50,000-ohm resistors respectively. The resulting circuit is shown in detail in Fig. 11-9.

In the second r.f. stage, the cathode resistor (*106*) was decreased from 250 ohms to 100 ohms. In order to raise the screen voltage on this stage the series screen resistor (*93-4*) was decreased from 100,000 ohms to 27,000 ohms. Since this made the S-meter read "high," the 150,000-ohm resistor to ground in the S-meter circuit was increased to 240,000 ohms. Fig. 11-7 of the earlier conversion will make this clear.

In order to keep the S-meter from going off scale when the r.f. gain was decreased when using m.v.c., a toggle switch was placed in one lead to the meter so the meter can be discon-

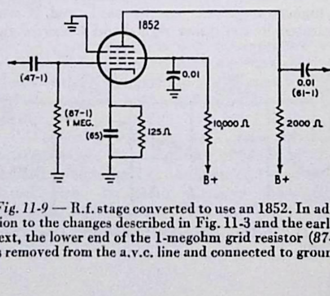


Fig. 11-9 — R.f. stage converted to use an 1852. In addition to the changes described in Fig. 11-3 and the earlier text, the lower end of the 1-megohm grid resistor (*87-1*) is removed from the a.v.c. line and connected to ground.

nected. The switch was mounted on the panel just to the left of the meter.

The i.f. gain was increased by decreasing the bias on the first and second i.f. stages. This was done by reducing the cathode resistor (*113*) from 400 to 200 ohms.

"Send-receive" switching is accomplished by cutting the center tap of the power transformer. The panel switch is paralleled by leads brought to a plug on the rear of the chassis for remote-control operation.

The author is indebted to many fellow hams from all parts of the country for these additional suggestions and they are offered so that more can benefit by them.

—*P. M. K.*

CONVERTING THE BC-348-O (AND BC-224) RECEIVER

THE BC-348-O receivers have two stages of r.f. and three stages of i.f., and with a few changes can be made to compare favorably in electrical performance with much higher-priced receivers. As supplied to the Army, the receivers were designed to operate from a 28-volt d.c. supply, but since all the tubes used in the receiver have 6.3-volt heaters the sets may easily and inexpensively be modified to operate from a 115-volt a.c. supply.

A number of the models of the BC-224 series differ from the 348s only in the heater circuit, so most of the changes described here can also be made to the 224s.

Power Supply

The one essential change is in the power supply to the receiver. First, the dynamotor chassis is removed and all the parts stripped from it. The terminal strip is the only part to be retained for installation. By the gentle use of a hammer and a block of wood the dimples that held the heads of the dynamotor mounting blocks can be flattened out so they will not interfere with the mounting of the new parts. The power supply diagramed in Fig. 11-11 may now be built on the old dynamotor chassis.

It is then necessary to separate the original 28-volt wiring into 115-volt power-supply wiring and 6.3-volt heater wiring. By clipping the ground connection loose from Terminal 7 of *SO-143* on the back of the chassis and removing the dial-light supply wire from Terminal 1 on the front

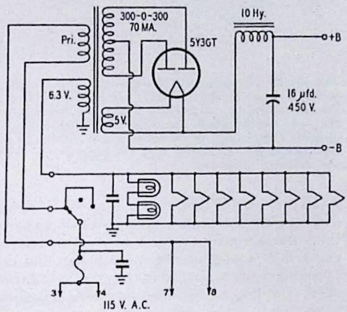


Fig. 11-11 — Circuit diagram of the power supply, showing rewired heater and dial-light circuit. The 115-volt connections can be made to the former 28-volt d.c. terminals.

section of the "AVC-OFF-MVC" switch, the original 28-volt supply circuit can be used to lead in and switch the 115-volt supply. Next, the tube heaters must be wired in parallel and *R-501*, the tapped resistor for heater balancing, removed from the circuit. Fig. 11-11 shows the rewired heater and dial-light circuit. *R-500* and *R-503*, the fixed and variable resistors in series with the dial lights, are disconnected and removed from the receiver. Changing the heater wiring for parallel operation is relatively simple if the method shown in Fig. 11-12 is followed. It is necessary to break the old heater wiring only at the two points marked with *X*s; the two sections of resistor *501* can simply be shorted out.

By connecting a jumper between Terminals 2 and 6 and connecting 115 volts a.c. to Terminals

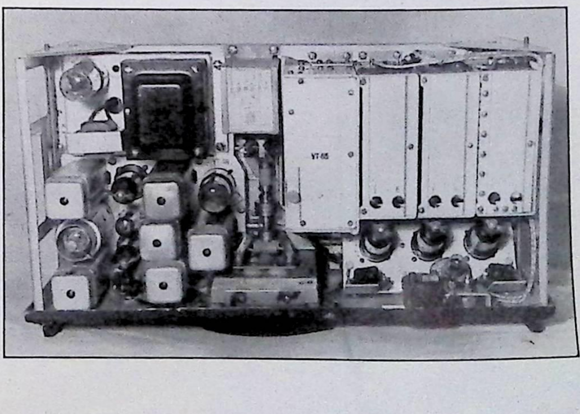


Fig. 11-10 — A top view of the modified BC-348-O, showing the power supply (upper left) that replaces the dynamotor and the S-meter with its potentiometer for zero adjustment (lower right). The meter is mounted in the space formerly occupied by the dimmer control. This view also shows the miniature power amplifier between two of the i.f. tubes.

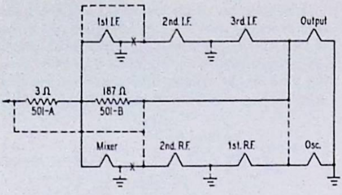


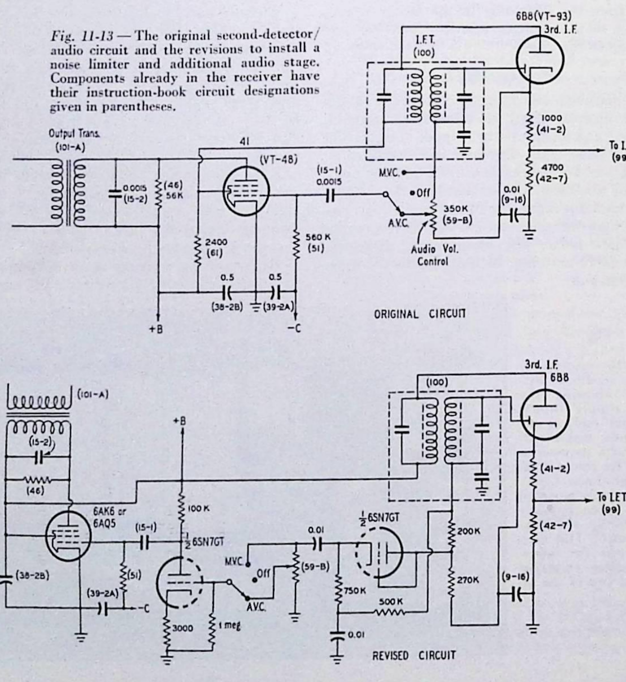
Fig. 11-12 — Rewiring the heater circuit. The original wiring is shown by the solid lines. Dashed lines indicate the changes to put all heaters in parallel. Xs indicate the only points where the original wiring need be opened. The changes in the lower row of tubes can all be made in the r.f. section; it is not necessary to open the oscillator shield can.

4 and 8 of *SO-143* the receiver is all ready to go and is pretty hot. However, it does lack some of the features usually available in amateur receivers, such as a noise limiter and S-meter, and the operating voltages applied to the r.f. stages do not allow operation at the most-favorable signal-to-noise ratio.

Noise Limiter

Since the author's QTH is badly beset by noise, the noise limiter was an item of the highest priority. A germanium diode was considered, but the back resistance of these crystals is lower than that of some of the resistors in the audio input circuit, and it was thought that they would not serve satisfactorily in a series-limiter circuit. A thermionic diode seemed to be the only solution to the problem. Since most limiter circuits result in a loss of audio gain it was decided to install an additional audio stage. Space for one miniature tube was found in the center of the i.f.-audio chassis. At the time the conversion was made there was no miniature twin triode available that had independent cathodes, so the easiest solution seemed to be to install a 6AK6 or 6AQ5 output tube in the new socket, and install a 6SN7 twin triode in the space occupied by the original output tube. (RCA has since announced the 12AU7 twin triode using a nine-pin socket slightly larger than the seven-pin button base. This tube has a center-tapped heater so that it can be operated on a 6.3-volt heater supply. If this tube is used for a noise-silencer-and-first-audio stage it is not necessary to move the output stage.) The modified audio system is shown in Fig. 11-13. The numbers in parentheses are the original circuit designations for parts already in the receiver. Actual values also are shown for assistance in identification. New parts are identified by their actual characteristics.

Fig. 11-13 — The original second-detector/audio circuit and the revisions to install a noise limiter and additional audio stage. Components already in the receiver have their instruction-book circuit designations given in parentheses.



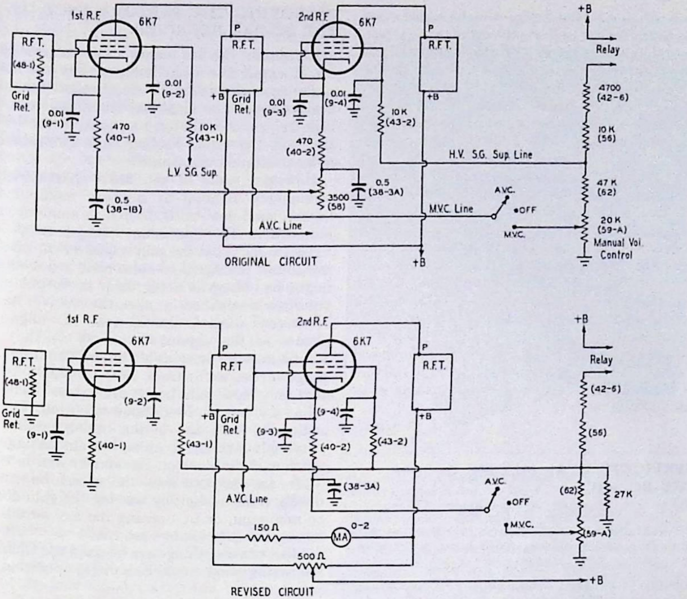


Fig. 11-14 — **R.f. circuit changes to take the first r.f. stage off the gain control and to install an S-meter.**

"Souping Up" the Front End and Installing an S-Meter

In general, the best signal-to-noise ratio can be obtained from a receiver when the first r.f. stage is operated at maximum gain. To obtain this condition the first 6K7 is removed from the a.v.c. and m.v.c. busses and is connected to the higher-voltage screen supply. When the first r.f. stage is removed from the a.v.c. bus, resistor *48-1* (0.1 megohm) in series with the grid return is left in the circuit to protect the grid of the tube from drawing excessive current should the receiver be overloaded by the local transmitter. The bottom end of resistor *40-1* is removed from the m.v.c. bus and grounded. The supply end of screen filter resistor, *43-1*, is disconnected from the blank pin of the first r.f. socket and connected to the blank pin on the second r.f. socket, which is the higher screen-voltage supply. After making these changes the receiver was tested on strong local stations and with a high-gain converter for six and ten meters no overloading was detected. All changes are completely diagramed in Fig. 11-14.

When a strong signal is applied to the receiver and it is operating with a.v.c., or when the manual volume control is turned down, the screen voltage on the tubes increases to quite a high value. This causes no difficulty when the tube bias is also increased, but since the first tube now operates at a constant bias it is necessary to improve the regulation of the screen-supply circuit. This is accomplished by connecting a 27,000-ohm resistor from the junction of resistors *56* and *62* to ground. In the b.f.o. section, the 10,000-ohm resistor that shunts the plate supply should be removed from the circuit to prevent lowering the screen voltage when the b.f.o. is turned on. This resistor is *43-4* in the original circuit designations.

Once the above changes are made, it becomes very simple to install an S-meter circuit. The variable resistor (*58*) on the end of the tuning condenser is removed and the connections shorted together. The mounting bracket for this rheostat should be saved to mount the S-meter zero-set control. A 1½-inch meter with a full-scale deflection of 2 ma. or less is installed in the space originally occupied by the pilot-light dimmer control, and the zero-set potentiometer is mounted to the right of it. These parts must be carefully fitted into the available space. The meter is then connected in a bridge circuit between the first and second r.f.-amplifier plates. As the grid bias of the second r.f. amplifier is varied, either by

a.v.c. or m.v.c., the bridge will be unbalanced and the meter will indicate the unbalance current. Since the tubes in the two r.f. stages are alike and are operated at the same electrode voltages in the absence of any a.v.c. or m.v.c. voltages, the drift of the zero point because of line-voltage changes is much smaller than would be the case were only one arm of the bridge circuit a vacuum tube.

A cable socket to fit *SO-143* could not be found, so it was replaced by a six-pin Amphenol plug. The casting that held *SO-143* was drilled so that the long No. 4 bolt could be located only 1/8 inch from the outside edge. Then with a little careful filing and drilling the six-pin plug was fitted into the available space and secured in place by the long No. 4 bolt. The output, relay (send-receive switch) and 115-volt connections are made to the plug.

Once the changes listed above are accomplished the BC-348-O leaves little to be desired in the way of a stable and easy-to-operate amateur communications receiver.

— W. B. Bernard

SERVICING XTAL FILTERS IN THE BC-348

Lack of ventilation in BC-348 receivers that have been converted for a.c. operation with built-in power supply sometimes leads to failure of the crystal-filter section. Excessive heat from the power supply melts the gummy substance covering the three-section crystal holder, causing it to seep into the holder and deposit on the crystal and the electrodes.

The remedy was found to be quite simple and easily performed. The crystal and its holder, which are directly behind the crystal switch, should be removed and taken apart. Clean the crystal and all parts of the holder by scrubbing with warm water and soap. Rinse and dry thoroughly, being careful to avoid touching the crystal with anything that will leave dirt or grease on it. Reassemble the crystal in the holder, seal all seams with Duco household cement, and wire it back into the circuit. Results are surprisingly good.

— Herbert K. Armistead, W4WM

ELIMINATING BACK-LASH IN BC-348 RECEIVERS

Back-lash in the tuning mechanisms of the BC-348 series receivers can be eliminated by slight adjustment of the screws that mount the tuning condenser. The holes in the bracket on the condenser are sufficiently large to allow the condenser to be moved far enough to take up the back-lash. It is only necessary to loosen the screws on the dial end of the condenser mounting bracket and the subpanel casting. Twist the screwdriver blade until the slack in the gears is taken up, and then retighten the mounting screws.

— Kenneth A. Jenkins

IMPROVING THE PERFORMANCE OF THE BC-342 RECEIVER

As it stands, the 342 makes a fair ham receiver. It's built like a battleship and is just about as stable, mechanically. Evidently a lot of thought has been given to electrical stabilization of the high-frequency oscillator, too, because the drift is low and the direct-reading dial calibration is quite accurately maintained.

However, some of the 342's characteristics, presumably dictated by military requirements, leave a good deal to be desired in amateur communication. The operating voltages on the r.f. tubes are such that the gain is held down, with the result that the signal-to-noise ratio is not what it might be. There is a big drop in output when the filter is switched in; also, the receiver has no selectivity control and normal i.f. alignment results in the crystal's working at the very maximum selectivity at all times. The frequency range of the set is from 1500 to 18,000 kc., so that only three ham bands are covered. There is a bad a.c. hum in headphone reception. There is noticeable back-lash in the tuning mechanism, varying in different receivers but amounting to as much as 5 divisions on the vernier dial in some. There are only two ways the set can be shut off during transmission: by turning the gain control to minimum, or by opening the a.c. switch and letting the tube heaters get cold.

Most of these things can be fixed up. Changing the tuning range would be a major operation, but

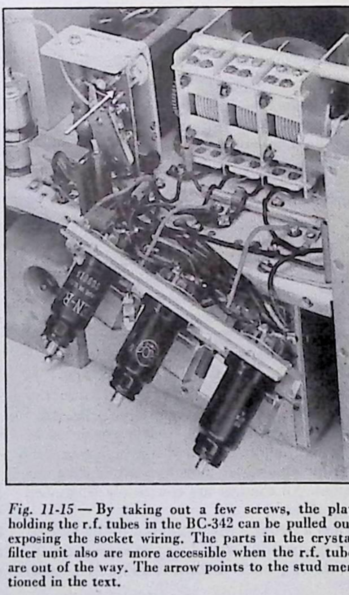


Fig. 11-15 — By taking out a few screws, the plate holding the r.f. tubes in the BC-342 can be pulled out, exposing the socket wiring. The parts in the crystal-filter unit also are more accessible when the r.f. tubes are out of the way. The arrow points to the stud mentioned in the text.

that problem can be dodged by building a converter for the frequencies higher than 18 Mc.; in fact, the set is rather nicely arranged for working with a converter because the shielding is excellent and the antenna input is designed for coax cable, both factors contributing to interference-free converter reception.

The electrical changes to improve the performance are fundamentally simple. Taking the various points in turn:

R.F. End

Boosting the gain in the r.f. stages — and particularly in the first stage — materially improves the signal-to-noise ratio. As the set is wired, the cathode resistors of the first and second stages — R_1 and R_7, respectively — are 500 ohms; these should be reduced to 250 ohms each. The screen resistors, R_3 in the first stage and R_9 in the second, should be reduced from the design value of 40,000 ohms to 20,000 ohms. These changes raise the screen voltage to 130, approximately, and reduce the grid bias at maximum gain to about 3 volts. It is also advisable to remove the first tube from the manual r.f. gain control so that this tube always runs wide open in c.w. reception with m.v.c.; this keeps the signal-to-noise ratio high when the r.f. gain is reduced to give a comfortable signal level.

To make the changes it is necessary to remove the shield plate at the rear of the chassis behind the r.f. and mixer tubes. This can be done by taking out the four screws on top and lifting off the plate. The screen resistors are on the mounting strip underneath the plate and are identified by the near-by circuit symbols. The easiest and quickest way to make the change in screen-resistor value is to shunt R_3 and R_9 with 40,000-ohm ½-watt resistors, rather than by substituting 20,000-ohm units directly, the original resistors being wired in such a way that it is a real problem to get them out.

The cathode resistors for the two r.f. stages are mounted alongside the tube sockets, and are inaccessible until the mounting plate (Fig. 11-15) for the tubes is removed from the chassis. This plate is held by the two threaded studs at the extreme ends at the rear and by two screws at the front. Take out the screws and remove the grid caps from the tubes; the plate can then be pulled out to the limit of the grid leads, making the socket wiring easy to get at. The cathode resistors are mounted between the cathode pin on the socket and an insulated tie point alongside; clipping the leads is the simplest way to get them out. The 250-ohm ½-watt substitute for R_1 should be soldered between the cathode pin and a convenient ground point such as the shell pin on the socket, but the replacement for R_7 should be connected to the same points as the original resistor. After these changes have been made the mounting plate and shield should be reassembled.

Raising the gain by this method should make the trimmer on the first r.f. stage show a definite peak on noise with the antenna disconnected.

Fig. 11-16 — A large-size tuning knob in place of the vernier control makes the BC-342 easier to tune in amateur work. This photograph also shows the octal socket installed in the cable outlet in place of the special connector supplied with the set. The socket takes an ordinary octal plug and provides a convenient outlet for filament and plate voltages for a converter, among other possibilities. Note that the cap (an item with high nuisance value) has been removed from the jack that has been switched over to the first audio stage.

Crystal Filter

The principal trouble with the crystal filter is that the capacitance of the phasing condenser is too large. This condenser (C_{51} in the circuit diagram) has a maximum of 50 μμfd. and has a switch blade on its rear shaft extension to short-circuit the crystal when the condenser is turned to maximum capacitance. In the "crystal out" position, therefore, the 50-μμfd. phasing condenser is connected directly across the secondary of the i.f. transformer. With the crystal in, the phasing condenser ordinarily is set at about one-fifth of maximum, or somewhere in the vicinity of 10 to 15 μμfd. As this capacitance is in series with the crystal-holder capacitance under these conditions, the shunting capacitance across the transformer secondary is less than 10 μμfd. Thus simply switching the crystal in and out causes a capacitance change of 40 μμfd. or more. The result is that if the transformer is lined up without the crystal it is badly out of alignment when the crystal is switched in, and vice versa.

The cure is quite simple: the crystal switch should be arranged to close when the phasing condenser is at *minimum* capacitance. Unfortunately, the switch blade is pinned to the condenser shaft — in a spot where it is practically impossible to get the pin out without wrecking the condenser and the surrounding parts. However, a small stud used as a stop to prevent continuous rotation of the condenser is mounted in the bake-

lite plate, and this stud can be used as a switch contact instead of the one normally provided. It is only necessary to solder a wire from the stud to the regular fixed contact and the job is done. Be sure to clean off any soldering flux so the edge of the switch blade will make good contact with the stud. The switch and stud are accessible from the rear of the receiver when the filter-assembly cover, held by four screws at the top corners, is lifted off.

As an alternative method, the switch blade can be forced around 180 degrees on its collar, since it is only crimped to the latter. It may break in the process, but if it does it can be soldered to the collar. This will permit using the old fixed switch contact.

The trimmer in the i.f. transformer secondary (on top of the "first detector" transformer) has to be adjusted after making this change. It may be lined up on noise with the crystal switched out. Thereafter the signal strength, when the signal is peaked on the crystal, should be the same with the crystal as without it. The crystal selectivity is not too great — just about optimum for ordinary operating.

As a refinement which makes the phasing control somewhat easier to operate, plates can be taken from the condenser stator to reduce the maximum capacitance. Removing four of the seven fixed plates still leaves plenty of phasing range and makes adjustment less critical. The plates can be broken from the solder holding them to the support rods and then fished out. It is not necessary to remove the filter assembly from the chassis, provided the r.f.-tube section is dismantled as previously described.

A.C. Hum

Some reduction in hum can be effected by adding capacitance to the filter, and it is possible to find room underneath the chassis for a couple of midget 8-μfd. electrolytics. However, the real cure is to shift the 'phones to the first audio stage. Either or both 'phone jacks can be used for this purpose. The lowermost one is the easiest to get at; simply clip the wire running to the jack spring and solder a lead from the spring to the grid prong on the 6F6 socket. With this change the headphone volume will be less, of course, but the hum disappears. The 6F6 socket can be reached by taking out the pin in the inner power-supply hinge, removing the two screws holding the power-supply unit to the top of the chassis, and swinging the power unit out of the way on the outer hinge.

If more headphone volume is wanted, it can be obtained by substituting a 6Q7 for the 6R7 second-detector first-audio tube. The cathode bias resistance should be changed, since the 6Q7 is a high-μ tube. Soldering a 300-ohm ½-watt unit across R_{28} will suffice; this resistor is on the mounting board at the edge of the chassis. A further increase in volume will result if a 50,000-ohm resistor is similarly shunted across R_{49}, the filter resistor in the diode circuit, the design value of this resistor being 0.5 megohm.

This method of connecting the headphones in the first audio stage makes no provision for silencing the loudspeaker when the 'phones are plugged in. More serious, however, is the fact that if no 'speaker is used, or its plug is pulled out when the 'phones are in use, the 6F6 output tube is left without a load. Strong signals or bursts of noise cause quite high voltages to build up across the primary of the output transformer — high enough to cause sparking inside the tube. The same thing happens, incidentally, when high-impedance 'phones are used in the second-audio jack; in one case we know of the voltage was high enough to break down the insulation in the shielded lead that runs from the transformer to the plate of the 6F6. An effective remedy for this is to replace the 'speaker jack with a standard jack of the shorting type wired so that the hot lead from the output-transformer secondary is shorted to ground when there is no plug in the jack.

Send-Receive Switch

The send-receive switch on the 342 does not shut off the receiver "B" supply as is customary in communication receivers, but if regular send-receive switching is wanted it can be incorporated by a simple change in the wiring. Remove the leads from the switch and tape the exposed ends. Ground one switch terminal. Take the bottom plate off the power unit and disconnect the high-voltage center-tap lead from the negative terminal of the filter condenser. This lead has a plain brown covering. It is long enough to reach to the switch terminal, so may be pushed through the grommet with the other power leads and soldered directly to the switch. The switch then breaks the negative high voltage before the filter, and so turns the "B" voltage on and off without the clicks that accompany switching in the positive output lead.

Back-Lash

The back-lash problem is a sticker. We haven't found a satisfactory solution to it, although from all indications it is wholly in the worm-gear combination that drives the condenser shaft and not in the gears connected to the tuning knobs. More intimate contact between the worm and the toothed gear might be the answer, but there seems to be no way to get it without taking the whole assembly off the chassis; there appears to be a possibility of adjustment but the condenser frame is pinned to the gear-assembly casting. The pins, as usual, are inaccessible without a major disassembly job.

In some cases an improvement can be effected by tightening the spring tension on the worm shaft, which can be done by carefully loosening the setscrew in the collar, pressing the collar tightly against the spring, and retightening the setscrew. This will prevent any thrust in the shaft and thus keep the worm from moving back and forth. In a couple of cases doing this reduced the back-lash by about one division on the vernier dial.

Odds and Ends

A number of other changes can be made in the receiver to make it more adaptable to ham work, although they have nothing to do with its electrical performance. One simple thing that makes tuning a lot easier is to substitute a big knob for the miniature job on the vernier control; the shaft is ¼-inch so any standard knob will fit. A large knob will cover up the vernier scale, which may be a disadvantage if the scale is used for logging purposes. However, it is probably preferable to log directly from the frequency scale.

Rubber grommets in the holes in the slide fasteners on the bottom will keep the receiver from scratching the operating table and make it practically impossible for the set to slide, even with a hefty push.

The cable outlet is practically useless unless a special plug is obtained to fit. However, an Amphenol MIP octal socket fits perfectly in place of the original connector insert, even to the mounting holes. The socket mounting plate extends a little beyond the edge of the receptacle, in one or two spots, but can easily be filed off so the cover can be replaced. Installing such a socket provides an easy means for bringing out filament and plate voltages for operating a converter, for example, and leaves extra contacts for external "B" switching (a lead in parallel with the hot lead to the send-receive switch) and for introducing a keying-monitor tone (a lead to the secondary — already brought out in the cable — of the interstage audio transformer). The unused wires originally running to the connector can simply be clipped off.

A tone control can be installed for cutting down high-frequency noise; a simple one is a 0.02-μfd. condenser connected between the grid of the 6F6 and ground. It can be cut in and out of the circuit by a toggle switch which may be mounted in the hole now occupied by the spare-fuse holder.

— *George Grammer, W1DF*

A.M. OR N.F.M. RECEPTION WITH THE WILCOX F-3

Very little modification is required to use the Wilcox F-3 receiver as the i.f. amplifier following a converter for a.m. reception. However, it is not especially difficult to go one step further and adapt it for narrow-band f.m. reception as well. The conversion described here will allow either true n.f.m. or a.m. reception.

The first step is to remove the protective shield box that covers the tubes and coils. The top and bottom of the chassis follow and then the front panel itself. This leaves the inside of the receiver nicely exposed so that any work to be done can be completed easily. The power transformer must be set back to provide a little depth behind the panel at one side, so two new holes should be drilled one inch to the rear of the present ones that hold the unit in place. This leaves ample space to mount a switch behind the panel on the right-hand side. This switch, mounted in the spot formerly occupied by the frequency nameplate, is a s.p.s.t. unit used to break the high-voltage center-tap lead from the transformer for send-receive control. The center control, marked "Noise Control," should be removed from the circuit and from the panel and the hole enlarged to take a d.p.d.t. switch for a.m.-f.m. change-over. In the f.m. position, the switch also shorts out the a.v.c. bus to give a little extra gain.

The next step is to change the crystal socket from the three-pronged aircraft type to an octal of the wafer variety. This requires drilling two holes, but in replacing the crystal shield can it will be found that two bolts will be enough. While the oscillator can be made self-excited, crystal control seemed a good idea because it provides an i.f. channel that is not going to wander in frequency when the set is jarred or the line voltage fluctuates. The crystal used in this unit was 3845 kc., with the oscillator below the

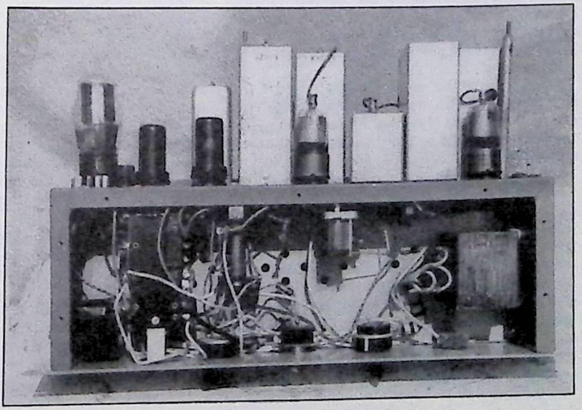


Fig. 11-17 — A view of the modified Wilcox F-3 with the cover off the chassis. The 6J5 audio tube is just to the right of the 80 rectifier. To the right of the 6J5 is the 6SJ7 limiter, and behind the 6SJ7 is the discriminator assembly.

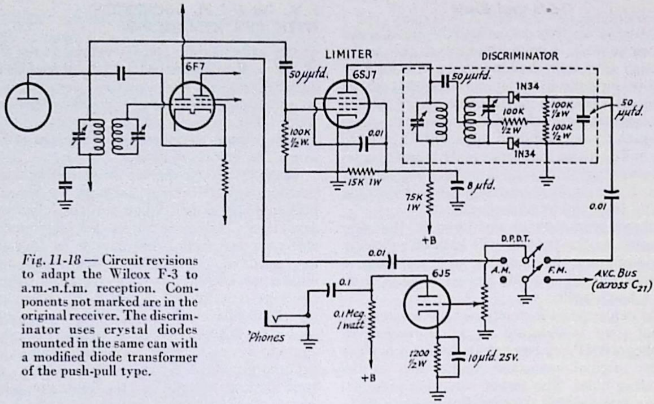


Fig. 11-18 — Circuit revisions to adapt the Wilcox F-3 to a.m.-n.f.m. reception. Components not marked are in the original receiver. The discriminator uses crystal diodes mounted in the same can with a modified diode transformer of the push-pull type.

signal frequency. This gives an i.f. of 4.3 Mc. (This frequency was used here because the existing converter had been built for use with a 4.3-Mc. wide-band i.f. for f.m. broadcast reception.) This i.f. is high enough to provide good image rejection but still low enough to have good gain. The converter was placed on 235 Mc. and its oscillator did not pull, so it was a natural conclusion that the unit would be just as satisfactory on the 28-, 50- and 144-Mc. amateur bands. It works beautifully on the forestry stations in the 74.5-Mc. region!

N.F.M. Reception

To make the unit function as an n.f.m. receiver, the 6C8 tube is removed and with it all of the socket wiring with the exception of the heater leads. This tube, formerly used for squelch and audio, is replaced by a 6SJ7, used as an f.m. limiter. Fig. 11-18 shows the revised circuit. Do *not* remove resistors R_{14} and R_{15} of the original circuit diagram shown in the book of directions. These resistors are necessary for the correct operation of the a.v.c. amplifier.

Next, remove the small coverplate beside the ex-6C8 socket. This will expose two knockouts, one for a tube and the other for an i.f. can. The tube cut-out should be fitted with an octal socket and wired for the 6J5 audio stage shown in Fig. 11-18. The i.f. cut-out may be used for the discriminator transformer, a modified full-wave diode i.f. transformer. The modification is simple: take the transformer out of the can, then remove the two diode plate leads and mount a three-lug tie point at the bottom of the wood dowel by a small wood screw. Then solder a 1N34 to each end of the secondary winding where the ends are attached to the trimmer lugs, with the negative terminal of the 1N34 at the coil. The other terminals of the 1N34s are soldered to two of the lugs at the tie point. As shown in Fig. 11-18, two 0.1-megohm resistors are connected in series between the same lugs, and a 50-μμfd. condenser is also connected between the same two points. One lug is grounded and the other lug is the connection for the audio output. A 0.1-megohm resistor and a 50-μμfd. condenser are connected to the center tap of the secondary winding, as shown in the diagram. The other terminal of the resistor goes to the common connection between the two 0.1-megohm resistors while the other terminal of the condenser goes to the plate end of the primary winding. This gives a well-shielded and compact discriminator assembly.

The 6J5 audio stage shown in Fig. 11-18 is resistance coupled for working into an external audio stage to drive a 'speaker.

Alignment of the i.f. is easy using a signal generator and output meter for the a.m. section. The f.m. discriminator may be lined up by using a high-resistance meter or a vacuum-tube voltmeter connected across the discriminator output. The bandwidth with the f.m. section in use very nicely handles the 30-kc. swing used commercially in the 30- to 42-Mc. band. On a.m. the bandwidth is narrow enough for good selectivity, but wide enough to take care of signal drift when using the receiver on 2 meters.

One word of caution: Be careful not to mess up the a.v.c. circuit; it uses an a.v.c. amplifier operating from negative voltages developed across the lower end of the voltage-divider string. Also, when taking the limiter input from the i.f. amplifier-stage output transformer, connect to the primary rather than secondary. This avoids loading the secondary and gives a better peak on a.m. reception, but does not affect the f.m. performance.

After using the unit on n.f.m. on 10 meters, especially on a signal that really saturates the limiter, you will definitely come to the conclusion that n.f.m. is not just something to read about — or to cuss about!

— *John A. Dinter, W8OAP*

ADDING A BC-453-A "Q5-ER" TO THE COMMUNICATIONS RECEIVER

Connecting the BC-453-A "Lazy Man's Q5-er" to the tail end of your receiver (provided its i.f. is within the tuning range of the BC-453) is as painless an operation as you'll encounter in any surplus deal. All you need is 24 volts a.c. at 0.45 ampere, and 250 volts d.c. at about 40 ma. These voltages are fed to the three pins on the top rear of the receiver, where the generator was mounted. The connections are shown in Fig. 11-19. If you're lucky, you'll be able to scare up a small control panel (designated FT-260-A) that plugs in at the front of the receiver. However, lacking the control panel, all you have to do is solder a few wires to the socket pins at the rear of the set, for leads to the audio output, gain control and b.f.o. switch. These connections are also shown in Fig. 11-19. You can mount the gain control and b.f.o. switch any place you want to, and if you want to keep the unit compact, you can make a small panel for the front, if you can't get an FT-260-A. The proper connections for this panel are also shown in Fig. 11-19.

The receiver has no a.v.c., but it wouldn't be too difficult to wire it in. The b.f.o. adjustment is a screwdriver one on the side of the set. When you get the receiver, unscrew the caps from the i.f. transformers and pull out the fiber pins — they'll move about 1/4 inch — to loosen the coupling to the "sharp" position. The coupling will already be loose on the center i.f. transformer, but tight on the other two. The audio output is not too great, but it is certainly adequate to run a small 'speaker.

Now that you have the power and controls to the BC-453-A, all that is left is to tie it in to the receiver. Even this is painless. If your receiver i.f. amplifier uses double-ended tubes, you can wrap an insulated wire around the grid lead to the last i.f. tube, and run the wire out a louver of the receiver. If your receiver uses single-ended tubes, pull out the second-detector tube, wrap an insulated wire once or twice around the diode plate pin, and put the tube back in the socket. Run the wire out a louver. Place the BC-453-A on top or alongside your receiver, connect the wire from the i.f. amplifier to the BC-453-A antenna binding post, and turn on your receivers. Peak a signal on the regular receiver, as indicated by the S-meter, and then tune it in on the BC-453-A. You're all lined up and in business!

— *W5KWI, W6OZB, W1DX*

GREATER SELECTIVITY WITH THE LAZY MAN'S "Q5-ER"

The advantages of low-frequency high-*Q* i.f. stages obtained from the now-famous Q5-er are many, but the selectivity is still not as great as it could be. A marked increase in selectivity was obtained by further increasing the separation between the i.f. coils in the BC-453 unit. This is done by removing the plug-in i.f. transformer, opening up the can, and removing the bottom coil and its form. Saw off the lower half inch of the form, and reassemble, cementing the coil in place.[1] Don't try to slide the coil down on the form, because it is impossible to do so without wrecking things!

Selectivity is increased to the point where the b.f.o. in the first receiver is almost useless. The critical test, digging for DX on 40 meters, was passed with flying colors. I estimate the effective bandwidth to be about 500 cycles, which is sharp enough to keep almost anyone happy. I can't recall having gotten more return for less effort in a long time.

— *Maynard B. Chenoweth, W8CUS, ex-W2GCC*

[1] In some units the coil forms are ceramic, which makes this a pretty tough job, but in many units the forms are mica-filled bakelite, which makes it a snap. — *Ed.*

PUTTING THE BC-457-A ON 7 AND 14 MC.

The electrical design of the 274-N is obviously unsuited for 14-Mc. operation, but, on the other hand, the construction of the 274-N units is above anything that the average ham can equal. In addition, it has a directly-calibrated dial. In other words, it is a good basic design to modify for general ham use. If we can keep the excellent mechanical features and modify the circuit to eliminate the above-mentioned difficulties we should have an excellent low-power transmitter.

For 7- and 14-Mc. output, a low-frequency unit, such as the BC-457-A (4-5.3 Mc.) or the BC-696-A (3-4 Mc.) should be used. The BC-457-A unit is the least expensive and the dial cali-

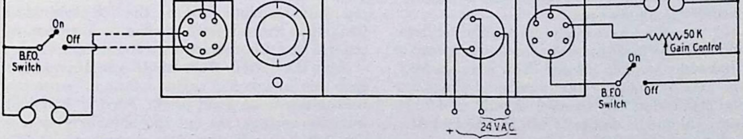


Fig. 11-19 — Pin connections for the terminals on the BC-453-A receiver, and suggested wiring of the controls. All connections are as viewed from the outside.

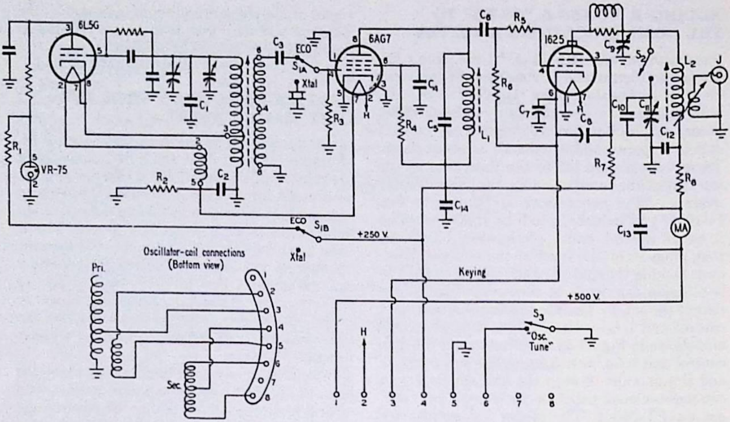


Fig. 11-20 — Schematic diagram of the SCR-274-N transmitter revamped for 7- and 14-Mc. operation. All parts not listed below are in the original unit, and are not changed.

C_1, C_5, C_6 — 100-μμfd. zero-drift ceramic.
C_2 — 0.0047-μfd. 600-volt mica.
C_3 — 100-μμfd. 600-volt mica.
C_4 — 0.0022-μfd. 600-volt mica.
C_7, C_8 — 0.02-μfd. 600-volt paper.
C_9 — 25-μμfd. midget variable, double-spaced.
C_{10} — 150-μμfd. zero-drift ceramic.
C_{11} — 50-μμfd. midget variable, double-spaced.
C_{12}, C_{14} — 0.01-μfd. 600-volt mica.
C_{13} — 0.006-μfd. 600-volt mica.
R_1 — 10,000 ohms, 10 watts.
R_2 — 12.6 ohms, 5 watts.
R_3 — 0.1 megohm, ½ watt.
R_4 — 10,000 ohms, 1 watt.
R_5, R_8 — 47 ohms, ½ watt.
R_6 — 33,000 ohms, 1 watt.
R_7 — 33 ohms, ½ watt.
L_1 — Permeability-tuned coil, National XR-50 form, 18 turns No. 22 enam. wire.
L_2 — See text.
J — Coaxial connector, Amphenol SO-239.
MA — 0–100 ma. d.c. meter, 2½-inch diam.
S_1 — D.p.d.t. rotary switch.
S_2 — S.p.s.t. ceramic rotary switch.

bration may be used for 14 Mc., as described below. However, either unit will work.

In order to achieve a driftless, chirpless signal, the following modifications to the unit are made:

1) A 6L5G low-filament-current triode is used as an oscillator. The oscillator circuit is padded down to 3.5 Mc. by means of additional zero-drift condensers.

2) A 6AG7 is added as a 7-Mc. doubler/crystal oscillator.

3) One of the 1625s is removed, and the remaining one is used as a 7-Mc. amplifier or as a doubler to 14 Mc.

4) The unit is rewired for 12-volt filament operation. Since 1625 tubes can be bought for about two bits and a 12-volt filament transformer for a buck, it pays to use the 1625 instead of an 807. In addition, it saves some nasty socket substitution along the way!

5) Some plates are removed from the oscillator and amplifier condensers to allow better spread of the 14-Mc. band on the dial. Now if we are foxy, and take out just the right number of plates, the dial calibration may be used directly on 14 Mc. (e.g., 4.0 on the dial is 14 Mc., 4.1 is 14.1 Mc., and so on).

These modifications entail a certain amount of labor but they will take only a few evenings, and the results are well worth the effort. When the job is finished you will have a 25-watt VFO/transmitter that will be hard to beat. It will have chirpless keying and practically *no* drift. (My modified unit has a measured warm-up drift of 400 cycles and a transmission drift of about 30 cycles on 14 Mc.) Interested? Well, then, hook up the soldering iron and let's go!

The first step is to remove all the unused components and wiring from the unit and to "strip it for action." The following should be removed:

From the top of the BC-457-A: the antenna relay, antenna loading coil, brackets and sliding arm, and antenna binding post. Take off the celluloid window and drill out the two little support pins. Also remove the frequency chart in the top right corner of the front panel. Oh, yes, you can toss the 1626 and 1629 away, too. Finally, clip out the plate lead of the *left-hand* 1625 (looking at the unit from the front). Also remove the free parasitic choke from the coil form.

From the bottom of the BC-457-A: (If you have gone this far you had better continue, 'cause the transmitter is no good now!) Turn it over and from the bottom take out the cathode relay and associated resistor, the plate choke between the two 1625 sockets, the 1625 screen by-pass condenser, the neutralizing condenser, the variable

padding condenser for the 1625 plate tank, resistor *7101* on the back of the chassis and its holder, and finally the crystal socket. Now clip out all the wiring from the 1625 sockets to the rear power plug. This sounds like a major project, but all the above will take only ten minutes with a screwdriver and a pair of wire cutters.

The last bit of major overhaul is to remove the 1625 socket. (Looking at the bottom of the chassis, it is the socket that was next to the cathode relay that you just removed.) This operation can best be done with a screwdriver and a light hammer. Using the screwdriver as a chisel, tap around the turned edge of the socket on top of the chassis and the whole assembly will drop out. While you are about it, remove in the same fashion the power plug from the rear apron of the chassis and in its place put an Amphenol 88-8 octal socket.

Now, with a pair of long-nosed pliers, carefully flex one rotor plate at a time in the ganged oscillator tuning condenser until it can be lifted out. Remove seven plates this way. Be careful, or you might wrench the rotor out of the ball-bearing sockets. Be gentle but firm! It's easy once you get the hang of it! Now remove all but two plates in the ganged amplifier condenser. The circuits will now track roughly, and just need a little touching up for excellent tracking. More of that later.

That's all there is to it! Now comes the easy job — getting everything back together again.

Assembly

First of all, mount a plate over the 1625 socket hole and mount an octal socket for the 6AG7 on that plate. The 6AG7 slug-tuned plate coil is mounted in front of the socket. A vertical shield is placed one inch behind the front tuning gang to support the crystal-oscillator switch and also to act as a shield between the output condenser and the 1625 grid components. Between the shield and the ganged condenser is placed the filament ballast resistor, R_2. A coaxial plug is mounted on the rear chassis wall next to the octal power plug. The 7-Mc. crystal socket is mounted against the shield next to the rotary "e.c.o./crystal" switch. An extension shaft is used to bring this switch out to the front panel. A tuning switch, S_3 in Fig. 11-20, is mounted to the right of the main tuning dial above the chassis. Finally the gaping hole left by the removal of the celluloid window is covered with a thin strip of dural. On this plate are mounted a 0–100 ma.d.c. meter and C_9, the amplifier trimming condenser.

Bandswitching in the 1625 Stage

It is possible to pad the 14-Mc. plate tank of the 1625 so that the tube operates as an amplifier on 7 Mc. A ceramic switch, S_2, a ceramic padding condenser, C_{10}, and a small variable condenser, C_{11}, are all mounted on the top of the shield cover and a flexible lead is run from the switch to the top end of the 1625 plate coil. After the unit is tuned up on 14 Mc., the switch may be thrown and the variable padder adjusted to resonate the plate circuit to 7 Mc. with the same setting of the panel-controlled plate condenser. Thus a shift from 14 to 7 Mc. may be made by merely turning the switch. The 1625 stage remains stable without neutralization on 7 Mc. To determine the operating frequency, the dial readings will have to be divided by two. If 7-Mc. output is not desired, the above components may be omitted.

Wiring

The unit is now ready for wiring. All the usual tried-and-true remarks about direct leads, good insulation and parts placement apply here. See the sketch at the bottom of Fig. 11-20 for the connections to the oscillator coil. The under-chassis wiring should not take more than two hours. When all the wiring is checked, the top coil shield should be removed and C_1, the oscillator padding condenser, added to the circuit. It should be placed atop the variable condenser.

The 1625 plate coil should be rewound with eight and one-half turns, using the same wire that was removed, and spacing the wire every other groove on the coil form. The variable-link winding is attached via a short piece of RG-58/U coax to the fitting on the rear of the chassis.

All wires other than r.f. leads should be laced and firmly fixed in place to prevent any frequency change because of movement. All r.f. leads should be made of bare No. 18 wire.

Testing the Unit

To test the unit, the 6L5G, 6AG7 and VR-75 tubes should be plugged in and a power supply such as shown in Fig. 11-21 connected. A potential of 12.6 volts should be applied to the filaments and the voltage on the 6L5G and 6AG7 measured. It should be 6.3 volts on each tube. Now the B-postive lead to the 6AG7 should

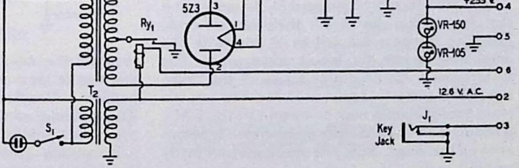


Fig. 11-21 — A suitable power pack for the rebuilt SCR-274-N transmitter.

C_1, C_2 — 8-μfd. 600-volt oil-filled.
R_1 — 0.1 megohm, 2 watts.
R_2 — 10,000 ohms, 50 watts, with slider.
L_1 — 20-hy. 150-ma. filter choke.
J_1 — Closed-circuit jack.
R_{y1} — 12-volt s.p.s.t. relay.
S_1 — S.p.s.t. toggle switch.
T_1 — 650–0–650 v. a.c., 150 ma.; 5 v., 3 amp.
T_2 — 12.6-volt 2-amp. filament transformer.

be removed temporarily and we are ready to align the oscillator stage.

A receiver and a 100-kc. frequency standard are needed to adjust the oscillator. First of all, the oscillator padding condenser in the top coil can should be set so that the oscillator tunes to exactly 3500 kc. with the main tuning dial set at "4 Mc.," and the oscillator slug set about half-way into the coil. Now tune the receiver to 14 Mc. and listen to the fourth harmonic of the oscillator. It, of course, should fall at 14 Mc. Now tune the main dial of the ECO (we can call it an "ECO" now, you're almost finished!) to 4.4 Mc., and see if the fourth harmonic falls at 14.4 Mc. If not, a little plate bending in the oscillator condenser gang is in order. One of the rotor plates of this condenser is slotted and may be used to correct the calibration. If the dial is calibrated at 4 Mc. and if 4.4 Mc. on the dial falls short of 14.4 Mc. on the receiver, for example, say 14.38 Mc., then the variable condenser is tuning too slowly and the variable plate should be bent *in*. By bending this plate and rechecking the calibration, the 4- and 4.4-Mc. marks may be made to fall exactly on 14 and 14.4 Mc. When this is accomplished, the oscillator will be actually tuning from 3500 to 3600 kc. Now the dial will track within one or two kilocycles across the whole 14-Mc. band. For the 7-Mc. band, the dial readings may be divided by two. Above 14.4 Mc., the calibration gets progressively worse, so if this unit is used for 28 Mc., and better tracking is desired, more time will have to be spent with the oscillator condenser. Believe me, it is an easy job, and the trouble is well worth the satisfaction of having a directly-calibrated dial.

Buffer and Final-Amplifier Alignment

Regulated plate voltage should be applied to the 6AG7 buffer and the "e.c.o./xtal" switch set to the e.c.o. position. The plate-coil slug should be tuned for resonance at approximately 7 Mc. When the "e.c.o./xtal" switch is thrown to *xtal* the plate slug may be adjusted slightly to allow the crystal to oscillate easily.

Nothing need be done to the amplifier ganged condenser. This stage tunes broadly so that no adjustment need be made to make it track after the necessary number of plates is removed from the condenser.

The 1625 should be plugged in its socket and the plate-tuning slug of the 1625 should be adjusted to resonate the coil to 14 Mc. with the amplifier trimmer, C_9, set at midcapacity. The plate current should dip to about 15 ma. when the 1625 is correctly tuned to 14 Mc. The ceramic plate switch should now be thrown to the 7-Mc. position, and the auxiliary padder set for resonance on this band. Now you are all set and ready to go!

The ECO unit will track across the 7- and 14-Mc. bands without any adjustment. The amplifier trimmer, C_9, need only be set to compensate for reactive loads on the 1625 plate circuit and then may be ignored. The modified unit will deliver 25 watts on both bands with crystal stability and excellent keying characteristics.

So there it is, a good VFO for a few dollars and a few hours' work. Not bad, eh?

— *William I. Orr, W6SAI*

14-MC. OUTPUT FROM THE BC-459-A

THE BC-459-A, originally designed for output in the 7-Mc. range, may be used to provide output in the 14-Mc. band with slight modification of the *LC* circuit in the amplifier stage. Fig. 11-22 shows one method by which this may be

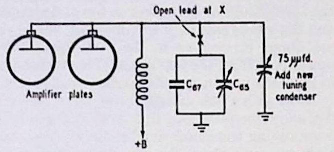


Fig. 11-22 — Substituting a 75-μμfd. condenser for the original components permits the amplifier tubes in the BC-459-A to work as doublers to 14 Mc.

accomplished. The original condensers, C_{67} and C_{65}, are cut loose from the coil, and a 75-μμfd. variable is substituted in their place. This, of course, will not be ganged to the oscillator tuning condenser, but it can be resonated separately without undue inconvenience.

— *John T. McIntosh, W8ZGO*

IT is possible to obtain 14-Mc. output from the BC-459-A and at the same time retain the gang-tuning feature. Amplifier padding condenser C_{67} (the one with the locked shaft) is removed, and ten rotor plates are removed from the other main tuning condenser. The plate coil is then pruned down to 5½ turns, and the tuning slug is removed. A 35-μμfd. padder is substituted for C_{67}, mounted with its a shaft projecting

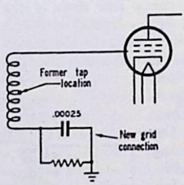


Fig. 11-23 — The revised grid circuit used when the BC-459-A is used for 14-Mc. output.

through the side of the chassis. Plate-circuit tracking is then adjusted by means of the new padder condenser and the top turn on the coil. The position of this turn can be adjusted to bring the tracking error to a minimum.

To obtain greater r.f. voltage for the final amplifier (to increase its doubling efficiency), the tap at which the grid leak R_{74} and the grid by-pass condenser are connected is moved down to the bottom of the coil as shown in Fig. 11–23. The value of the grid by-pass condenser, C_{58C}, is changed to 0.00025 μfd. from the 0.05-μfd. value originally in the circuit. This change was neces-

sary to reduce the amount of chirp encountered in keying. The fixed neutralizing condenser, C_{62}, which was connected from the cold end of the grid coil to the plate circuit, was removed, as it is no longer needed.

— *W1DX*

MAKING USE OF THE ARC-5 TUNING EYE

THE BC-457 and BC-459 transmitters were designed to work from a 24-volt d.c. supply. Under these conditions, the 1000-ohm resistor between the 24-volt d.c. line and the cathode of the "magic-eye" tube develops the correct bias for proper operation of the tube in conjunction with the built-in crystal calibrator.

Most hams revise things so that the filament circuits operate from a 24-volt a.c. source. With a.c., the magic eye will not react. This can be corrected easily, however, by the following method: The 1000-ohm resistor is removed from the cathode circuit of the magic-eye tube, and a 15,000-ohm 2-watt resistor is connected between the cathode and the B-plus line as shown in Fig. 11-24. (This assumes that the oscillator and the screen grids of the amplifier are being supplied from a 200-volt source.) With this small

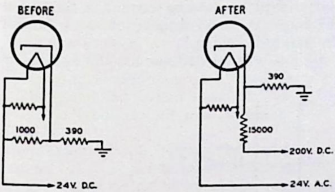


Fig. 11-24 — Simple change required to permit use of the tuning eye when a.c. is used on the filaments of an ARC-5 transmitter.

change the resonance indicator will give a very clear and definite shadow when the oscillator is tuned through the crystal frequency. Note that the 390-ohm resistor that is connected from the "magic-eye" tube cathode to ground is left in its original position.

— *F. W. Wright, jr., W2UWK*

CURING CHIRP IN COMMAND TRANSMITTERS

MY BC-459-A chirped, and from what I've heard on the air, most everybody else's does, too. I tried various methods of keying, and extremes of voltage stabilization, but the chirp persisted.

Checking with a good v.t.v.m. showed 12.6 volts on the filaments with the key up, but from 18 to 22 volts when the key was closed! The added voltage was r.f.

To remedy this situation, shielded filament wire was substituted in the rig, with by-passes at each end of the wire. Old microphone cable (with high r.f. losses) seemed best. A heavy copper strip was run across the chassis, and the "cold" ends of the 1625 filaments and the cathodes were connected to it to get a good ground. This change resulted in chirpless keying for me, and has done the same for all the others to whom I have passed this hint.

— *Alfred Scott Cline, W6LGU*

N.F.M. ADDED TO THE BC-459-A

IF you are using a 40-meter ARC-5 transmitter (BC-459-A) as the VFO in your 28-Mc. 'phone rig, don't overlook this simple method of using it also as a narrow-band f.m. exciter. All that you

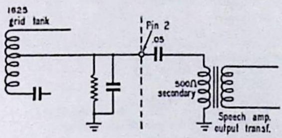


Fig. 11-25 — A simple method of using the BC-459-A as an exciter for n.f.m. work.

need is the ARC-5, your present speech amplifier (assuming that its output transformer has a 500-ohm tap on its secondary), and a 0.05-μfd. paper condenser.

The connections are made as shown in Fig. 11-25. The audio voltage is fed to the grids of the amplifier tubes in the BC-459-A through Pin 2 on the 7-pin power connector. (They are already connected to this pin in most units.) The effect of the fluctuating bias produced under modulation is to vary the frequency of the oscillator slightly. Not much power is required, and any amplifier capable of delivering between 3 and 8 watts should do the job. The setting of the audio gain control can be determined by trial. Too much audio will cause distortion and fluctuation in the meters. The proper setting can be determined by testing with other stations. Some have called this grid modulation, but tests made with an oscilloscope prove it to be f.m. While some a.m. is present at the output of the BC-459-A, the action of the following doubler stages, operating Class C, washes out the a.m., leaving only f.m.

Reports obtained with this set-up on the air have been excellent. The audio level is high, and the signal is easy to tune. It makes a swell addition to any station, especially where BCI problems have been encountered.

— *Don Imhoff, W8YFS*

A MODIFICATION OF THE BC-610 EXCITER UNIT

A GREAT MANY of the famous BC-610 transmitters, used extensively by the services in the war, have found their way into ham shacks, via the surplus market. While these rigs performed ably, they have certain shortcomings that can be corrected with a minimum of effort. The principal objection is to the crystal oscillator-

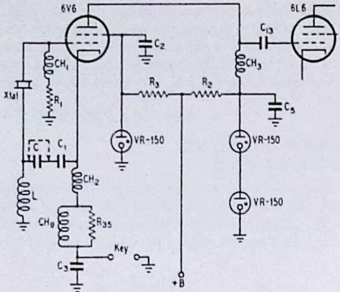


Fig. 11-26 — The original circuit of the oscillator and doubler portions of the BC-610 exciter unit.
C_1, C_2, C_3 C_5 — 0.006-μfd. mica.
C_{13} — 150-μμfd. mica.
R_1 — 33,000 ohms, 1 watt.
R_2 — 5600 ohms, 20 watts, wire-wound.
R_3 — 15,000 ohms, 20 watts, wire-wound.
CH_1, CH_2 — 1-μh. r.f. choke.
CH_3 — 2.5-mh. r.f. choke.
CH_9 — 10-mh. r.f. choke.

"MO" circuit. The crystal-oscillator circuits do not provide much in the way of operating flexibility, and the chirp of a BC-610 operating on "MO" was a distinguishing feature of our wartime radio circuits.

The modifications described here involve complete elimination of the "MO" circuits, and revision of the crystal oscillator to the highly-flexible Tri-tet circuit, arranged so that it may also be driven as a doubler by a VFO of suitable stability. In addition, one of the tuning units is modified to provide output from the exciter in the 28-Mc. range.

At W4CT only the exciter portions of the BC-610 are used. These were obtained in the surplus market at reasonable prices, and were used as the foundation for a 100-watt unit that is used to drive a push-pull 100TH kilowatt final operating in the 7-, 14- and 28-Mc. bands. The original circuits of the exciter were retained wherever possible. Thus, the modifications described here apply equally to complete BC-610 units.

The physical arrangement is shown in the photograph. The exciter deck ($11.95) was mounted on a 17 × 13 × 1-inch chassis. An aluminum panel was then made with a cut-out through which the tubes and the three plug-in tuning units ($1.25 each) could be removed. A 200-volt bias pack and a 600-volt 200-ma. plate supply were built on the rear of the exciter chassis. Metering was accomplished through a 0-200 ma. panel meter, arranged so that it could be switched to the desired circuits. Advantage was taken of the fact that the exciter deck was already wired for reading current in the 6L6 and 807 stages. A closed-circuit jack was installed on the panel for keying.

In the original 610 circuit, the parallel 807

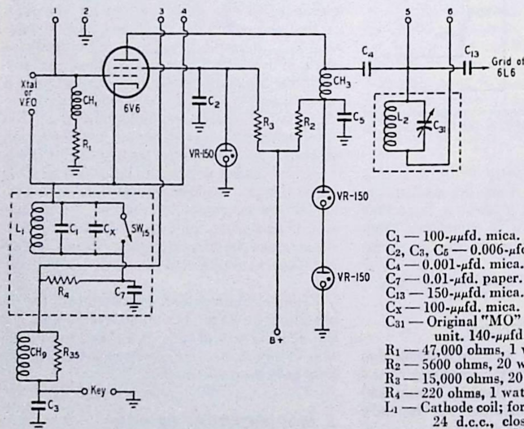


Fig. 11-27 — Schematic diagram of the revised oscillator circuit for the BC-610 exciter unit. A Tri-tet circuit is used, with provisions for connection of an external VFO. The components enclosed in dotted lines are mounted within the individual tuning units. All others are on the exciter deck. Terminal connections at the top of the diagram represent the pins on the tuning units through which the individual connections are made, and are included for reference only. See Figs. 11-29 and 11-30 for actual connections.

C_1 — 100-μμfd. mica.
C_2, C_3, C_5 — 0.006-μfd. mica.
C_4 — 0.001-μfd. mica.
C_7 — 0.01-μfd. paper.
C_{13} — 150-μμfd. mica.
C_X — 100-μμfd. mica.
C_{31} — Original "MO" tuning condenser from tuning unit. 140-μμfd. variable.
R_1 — 47,000 ohms, 1 watt.
R_2 — 5600 ohms, 20 watts, wire-wound.
R_3 — 15,000 ohms, 20 watts, wire-wound.
R_4 — 220 ohms, 1 watt.
L_1 — Cathode coil; for 3.5-Mc. crystals: 9 turns No. 24 d.c.c., close-wound on 1½-inch diam. form; for 7-Mc. crystals: 6 turns No. 22 d.c.c., ⅝ inch long, on 1½-inch diam. form.
L_2 — Oscillator plate coil — 3.5 Mc.: 85 turns No. 26 d.c.c. close-wound; 7 Mc.: 40 turns No. 24 d.c.c. close-wound; 14 Mc.: 25 turns No. 18 d.c.c. close-wound. (All wound on 1-inch diam. forms from tuning units.)
CH_1 — 1-μh. r.f. choke.
CH_3 — 2.5-mh. r.f. choke.
CH_9 — 10-mh. r.f. choke.
SW_{15} — D.p.d.t. toggle switch (one section unused).

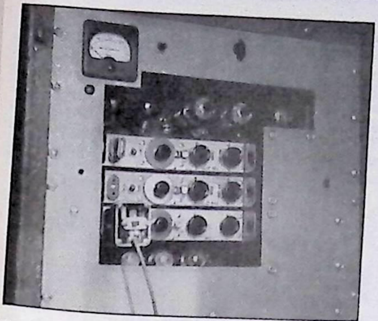


Fig. 11-28 — **Front-panel view of the revamped BC-610 exciter unit in use at W4CT.**

are operated as doublers whenever used to obtain output at 14 Mc. and above. We desired to avoid this wherever possible to take advantage of the additional output obtainable when they are operated straight through. With the revised oscillator circuit, this is possible except when output at 28 Mc. or higher is required. Tuning Unit TU-52 (original range 6.35 to 8 Mc.) was selected for 7-Mc. output. For 14-Mc. output, TU-54 (12 to 18 Mc.) was selected. Another TU-54 was revamped for 28-Mc. output.

The original circuit diagram is shown in Fig. 11-26, and the revised circuit in Fig. 11-27. The modifications are simple to perform.

After removal of the covers of the tuning units, all of the master-oscillator and crystal-oscillator circuit components were removed except the crystal socket, the d.p.d.t. toggle switch and the 140-$\mu\mu$fd. variable condenser. The units were then rewired as shown in Fig. 11-29, suitable coils, as specified below Fig. 11-27, being used to produce output in the desired range.

The changes required in the exciter-deck wiring are few. Sections 1 and 2 of band-selector switch SW_{11} were rewired as shown in Fig. 11-30. In addition, C_1, the 0.006-μfd. condenser in the original cathode circuit, was removed and the cathode of the 6V6 oscillator was tied directly to the rotor arm of $SW_{11\text{-}2}$. Choke CH_2 was also removed from the cathode circuit, and although this is not essential, its removal results in crisper keying. A 0.001-μfd. mica condenser, C_4 in Fig. 11-27, was connected from the plate of the 6V6 so that it would be in series with C_{13}. The junction of these condensers serves as the "hot" end of L_2.

In this particular application, as mentioned above, the exciter deck was used to drive a separate final amplifier, instead of being capacity-coupled to the single-tube amplifier built into complete 610 units. To accomplish this, it was necessary to wind output links on the 807 plate coils, and then to switch the links through an added double-pole three-position ceramic switch, as shown in the diagram. In cases where the original capacitive coupling is to be retained, this switch will not be needed, and the link windings on the plate coils may be omitted.

Millen 1½-inch diameter coil forms were used for the 6V6 cathode coils, although they might well be wound on the ceramic form that was removed from the tuning units during modification. Plate coils for the 6V6 stage were wound on the

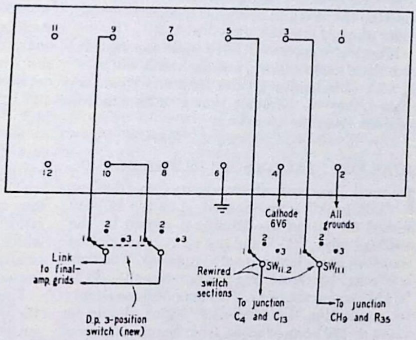


Fig. 11-30 — **Revisions required in the wiring at the sockets for the tuning units. Only those connections which are changed from the original circuit are shown.**

ceramic forms that were originally used as the master-oscillator coils. These are about 1 inch in diameter, and are identified as L_{13} in TU-52, and as L_{35} in TU-54. Winding details are listed below Fig. 11-27. The original "MO" tuning condenser is used in the 6V6 plate circuit, the rotor being grounded to the metal shield can. One section of the d.p.d.t. switch SW_{15} is used to short the cathode coil when operation at the crystal fundamental is desired. C_X is required with 3.5-Mc. crystals.

To modify TU-54 for 28-Mc. output, it is necessary, in addition to the changes described above, to rewind the 807 plate coil so that the desired range may be tuned with the existing tuning condenser. Half the number of turns, wound in exactly the same space occupied by the original coil, does the trick nicely.

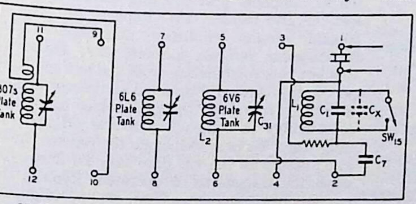


Fig. 11-29 — **Connections to the terminals within the revised tuning units. All grounds are consolidated at Terminal 2.**

Results with these changes have been very satisfactory. TU-52 is used for 7-Mc. output with either 3.5- or 7-Mc. crystals, or with a 3.5-Mc. VFO. TU-54 is used for 14-Mc. output with either 7- or 14-Mc. crystals, or a 7-Mc. VFO. The 6L6 stage and the 807s are operated straight through in some conditions, yet no self-oscillation has occurred, even though neither stage is neutralized. For 28-Mc. operation, the revamped TU-54 is used with 7- or 14-Mc. crystals, or a 7-Mc. VFO. In this unit, it was found better to operate the 6L6 straight through, doubling in the 807 stage.

If desired, the 3.2- to 4-Mc. tuning unit (TU-49) may be modified along similar lines to obtain 3.5-Mc. output from 1.75- or 3.5-Mc. crystals, or a 1.75-Mc. VFO, although this was not attempted.

Adequate drive for either c.w. or a.m. 'phone operation of a pair of 100THs running at 900 watts input is obtained on all bands with the modified exciter. Keying, when using crystal control, is perfect, and equally satisfactory results have been obtained using a Millen VFO, connected to the 6V6 grid by means of an old crystal holder plugged into the crystal socket.

Owners of complete BC-610 units can benefit from these modifications, and the result will be a rig with considerably greater flexibility than the original. Any of the other tuning units may be modified along the same lines.

— Lt. Col. C. R. Offringer, USAF, W4CT

CURE FOR "TALK-BACK" IN THE BC-610

In most instances where serious "chatter" or "talk-back" is experienced when the BC-610 is used on 'phone, the trouble is caused by the overload relay, *RY-5*, and not by the modulation transformer, as is commonly supposed. The cure is effected by connecting a large capacity, 30 to 50 μfd., across the relay. This may be done simply by connecting the condenser, which should be rated at 150 volts or more, from the center tap of *T-6* to ground.

J. K. Hall, jr., W4KCT

A "BANTAM ONE-WATTER" FROM THE BCR-746-A TUNING UNIT

A bantamweight "peanut-whistle" rig can be built for a few dollars by using a surplus BCR-746-A tuning unit as a foundation kit. Fig. 11-31 is the wiring schematic of such a transmitter; most of the components shown will be found in the unit. A 1S4 is used as the crystal oscillator, being powered by a 1½-volt "A" cell and 30 to 90 volts of "B" batteries. Connections to the antenna, key and batteries are brought out to the pin jacks in the fiber bottom plate of the unit. The schematic diagram shows link coupling to the antenna but a single-wire antenna could be tapped in at point *X* and worked against ground.

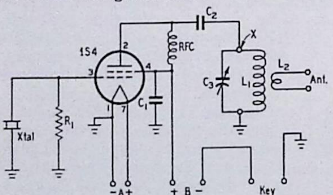


Fig. 11-31 — C_1, C_2 — 0.0047-μfd. mica; C_3 — 140-μμfd. midget trimmer; R_1 — 47,000 ohms; L_1, L_2 — depend on band and *XTAL* used (3.5 Mc.: L_1 43 t., L_2 4 t., No. 30 d.s.c. on ¾-inch diam. plug-in form); *RFC* — 2.5 mh.

In on-the-air tests, distances up to 400 miles have been covered with this rig. An 80-meter crystal was used, and the input was 0.8 watt!

— Ernest B. Lindsey, W4BIW

BETTER RESULTS ON 144 MC. WITH THE SCR-522

Here is a complete conversion process which should help 522 owners to get more out of their equipment, both transmitting and receiving.

Stepping Up the Receiver Sensitivity

A considerable improvement in receiver sensitivity can be achieved by substituting 6AK5s for the 9003s used in the r.f. and mixer stages. Stepping up the r.f. gain introduces complications, however. The 6AK5s show marked tendencies toward self-oscillation, correction of which required extensive experimentation with grounds and by-passes. It is often not appreciated that high S-meter readings and lots of receiver noise do not necessarily mean high sensitivity. In the case of the much-converted 522s worked on here, we found that each of the steps enumerated below tended to "cool down" the receiver, reducing the noise, but improving the signal-to-noise ratio. The improvement was such that signals which are completely inaudible on a 522 in its original form are copied solidly with the converted jobs.

Insofar as possible, the part numbers used in the service manual are used in the conversion process detailed herewith, and the parts to be changed are also described in sufficient detail to permit following the process even if no schematic diagram is available. First, remove the r.f. and harmonic-generator sections. Change the r.f. amplifier grid and plate coils and the mixer grid coil from two to three turns, copying the general size and shape of the original coils otherwise. These coils are numbered on the schematic diagram as *222*, *223* and *224* respectively. Remove the r.f. amplifier grid coupling condenser, *201*, and the grid resistor, *251*. Replace *201* with a 30-μμfd. ceramic condenser, and connect the 0.47-megohm resistor, formerly *251*, across it. Connect this combination from the hot coil support to the 6AK5 grid terminal as directly as possible. This cuts down the capacitance to ground considerably in comparison to the original arrangement. Be sure to include the resistor, however; otherwise the r.f. tube may be destroyed when the transmitter is operated. Replace the r.f. amplifier screen resistor, *267-8*, originally 0.1 megohm, with a 15,000-ohm ½-watt resistor. Add a by-pass (680-μμfd.) at the un-by-passed

cathode terminal, Pin 2, and a 500-μμfd. silver-mica button-type by-pass at the cold end of the r.f. plate coil to ground. Add a ground lead at the left side of the r.f.-grid stator terminal and at the left side of the mixer-grid stator terminal, as viewed from the bottom of the condenser assembly with the front end at the left. The purpose of these ground connections and by-passes may not be clear to one who has not had extensive v.h.f. receiver experience, but rest assured, they *are* necessary. Though the points in question are already "grounded" in the conventional sense, it is only through leads or framework of appreciable length. These relatively long paths to ground provide common coupling for the input and output circuits of the r.f. stage, with a resulting tendency toward self-oscillation. Their positions are shown in Fig. 11-32.

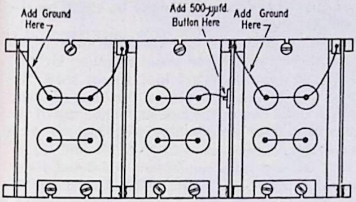


Fig. 11-32 — **Sketch of the bottom of the tuning condenser for the r.f. section of the 522 receiver, showing placement of grounds and by-passes needed when 6AK5s are substituted for 9003s. The front end of the tuning-condenser assembly is at the left.**

The antenna coupling coil should be increased to 2 turns, or possibly 3, if 300-ohm transmission line is to be used. The tendency to regeneration, which develops when the 6AK5s are used, is reduced by tighter antenna coupling than the original arrangement provides. This is shown by the reduction in noise level which takes place when the antenna coupling is increased. The correct spacing for the 2-turn coil is approximately 3/16 inch from the r.f. coil, when 52-ohm coaxial line is used, though this should be adjusted for optimum results with the particular antenna system used with the receiver.

Moving to the mixer stage, ground both cathode leads. Replace the mixer grid condenser, *203-1*, with a 30-μμfd. ceramic. Remove the 1.8-megohm grid resistor, *255-1*, and connect it across this condenser. Remove the 60-μμfd. mica condenser from the mixer plate coil in the i.f. transformer and connect it right at the mixer plate terminal to ground. The plate potential on the 6AK5s must be dropped to 150 volts, approximately. This is done by changing the resistor *263-1*, in the mixer plate lead, from 4700 to 20,000 ohms, 2 watts. The lead from this resistor to the r.f. section should be removed from the top of the resistor and reconnected on the bottom. This allows it to serve as a dropping resistor for the mixer stage and r.f. plates and screens.

Next the bandspread is increased by removing plates from the variable condensers. The rotor plates should all be removed except the center one in each section, being careful not to break the ceramic shaft. From our own sad experience, we know that these shafts break *very* easily! In modifying the stators, remove three plates from each side. Unsolder the tie strap at the top of each section, remove the two middle plates, and resolder the tie strap. This results in a triple-spaced condenser of three plates, which provides a tuning range of approximately 143.5 to 148.5 Mc.

Now we turn to the oscillator harmonic-amplifier section, from which we remove the crystal sockets, crystal switch, slug-tuned plate coils *227-1* through *227-4*, and the condensers and resistors in the harmonic-generator grid and plate circuits, numbers *204*, *205*, *262-1*, *202-15*, *261*, *203-2* and *255-2*. Make a four-turn coil and install it in place of *226* in the 9002 plate circuit. Ground the cathode terminal. Shift the plate lead to the opposite condenser terminal. Insert a 50-μμfd. ceramic condenser between the 9002 grid terminal and the condenser terminal where the plate was formerly connected. Remove the two by-passes, *202-13* and *202-14*, from the point where the B-plus is fed into the coil through the 27,000-ohm resistor, *260*. Connect a 22,000-ohm resistor from the 9002 grid to ground. This converts the 9002 into an oscillator stage. The following stage operates as an amplifier, as previously.

Remove resistor *255-2* and condenser *203-2* from the isolating-amplifier grid lead and put in a one-turn coil to ground from the 9003 grid, for coupling output from the oscillator to the amplifier grid. The isolating-amplifier plate coil should be two turns, ½-inch diameter, positioned as the original was, to couple the injection voltage into the mixer grid coil. This coil should be loaded with a low-value carbon resistor, the actual value of which may have to be determined by experiment. We have found various values from 270 to 500 ohms to be optimum in different receivers. The spacing will be about ¼ inch between the two. Isolation is very good with this arrangement

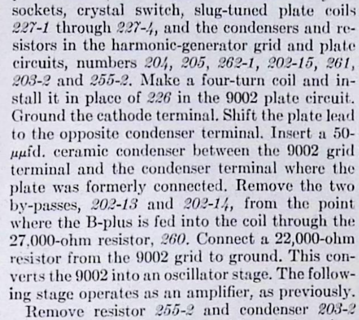


Fig. 11-33 — **Schematic diagram of the oscillator and isolating-amplifier circuits which replace the harmonic-amplifier stages in the 522 receiver.**

and there is no oscillator pulling. Injection voltage, measured across the mixer grid resistor with a vacuum-tube voltmeter, should be about 1.2 volts.

The plates in the tuning condensers in this section should be cut down in the same manner as for the r.f. section. The process will be similar,

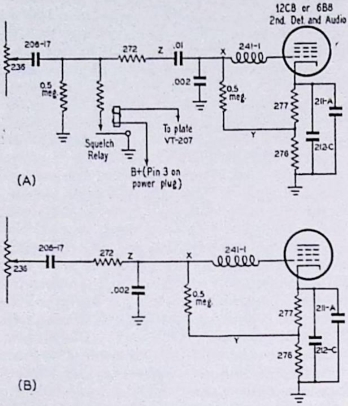


Fig. 11-34 — Suggested circuit for first audio stage in the 522 receiver, replacing the transformer coupling. Circuit A should be used if the squelch circuit is retained.

except in the case of the oscillator condenser which has one more rotor and one more stator plate than the other condensers. The end result should be the same, however: a triple-spaced condenser with two stator plates and one rotor plate in each section. The oscillator tuning range will be approximately 131.5 to 136.5 Mc. This circuit is shown in Fig. 11-33.

In the audio system the transformer (*295*) between the diode and the first audio should be removed and replaced with the coupling circuit shown in Fig. 11-34. Tie a 680-$\mu\mu$fd. mica condenser between the plate side of the first-audio load resistor, *266-3*, and ground. This reduces receiver noise which was apparently the result of r.f. from the front end of the receiver getting into the audio system. This is further reduced by inserting a shield plate between the r.f. section and the audio portion of the receiver. This shield, an aluminum plate about 1¾ by 4 inches in size, is mounted between the r.f. section and the terminal strip at its right, when the receiver is viewed from the bottom with the r.f. section at the left. Prior to the installation of these by-passes and the shield, the set noise increased more rapidly than the signal as the audio gain was turned up.

An increase in i.f. gain can be effected by decreasing the value of the third i.f. cathode resistor, *270*, to 200 ohms. The receiver is now ready for tuning up, unless it is to be converted to 6-volt operation, in which case the miniature tube sockets should be rewired for parallel connection. The tube line-up, for 6-volt service, is as follows: r.f. and mixer, 6AK5s; oscillator, 9002; isolating amplifier, 9003; 1st, 2nd and 3rd i.f., 6SG7s; 2nd detector, a.v.c. and 1st audio, 6B8; 2nd audio, 6J5.

Converting the Transmitter

Working over the transmitter is a much simpler process. Many are used in exactly the original form, but improvements in both the quality and quantity of the signal may be made by the following simple changes:

Remove all relays. Tie the grid leads which come down through the shield together. Ground the loose volume-control lead (bare) wire. Remove the feed-back circuit on the terminal strip at the audio end of the chassis, unless use of the tone modulator is desired. This consists of three 0.5-megohm resistors, *140-2*, *140-3* and *140-4*, two 0.001-μfd. mica condensers, *105-3* and *105-2*, and one 5000-ohm resistor, *142*. Cut down the oscillator plate condenser by two plates on each side, and the first multiplier by four plates on each side. The second-multiplier and amplifier condensers should have only one stator plate on each side left. These reductions in tuning range are merely for greater ease of adjustment. Remove the flexible plate leads from the 832s and substitute strips of silver or copper ribbon. This makes a considerable improvement in the efficiency of the two 832 stages.

In its original form the 522 transmitter has modulation applied to the screens of the 832 tripler, along with the plates and screens of the final. The quality can be improved considerably by removing the modulation from the tripler screens, which can be done by lifting the yellow shielded lead from the junction of the two 40,000-ohm resistors, *133-1* and *133-2*, and reconnecting it on Terminal 2 on the modulation transformer, *160*. The blue wire on the resistors should be left

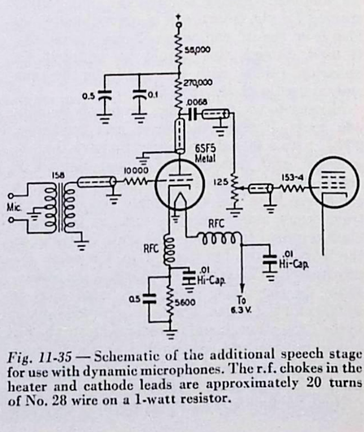


Fig. 11-35 — Schematic of the additional speech stage for use with dynamic microphones. The r.f. chokes in the heater and cathode leads are approximately 20 turns of No. 28 wire on a 1-watt resistor.

in place, as it supplies modulation to the power-amplifier screens. An additional audio stage can be added if more gain is needed, for use with crystal or dynamic microphones. The circuit used here with a Turner 101B microphone is shown in Fig. 11-35. Considerable care is required to prevent r.f. feed-back troubles, when this amount of gain is used. The r.f. chokes and the 10,000-ohm resistor should be placed right at the tube socket. Other compounds may be mounted on the terminal board formerly used for the tone-modulator components, making a neat and professional-appearing job. The tube should be the metal type, only, and the by-passes should be of good quality. Shielded leads should be installed as shown. The by-passes below the chokes in the cathode and heater leads may not always be necessary. Some units have worked OK without them.

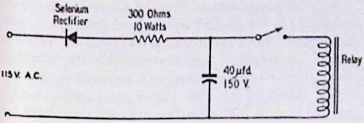


Fig. 11-36 — **Rectifier circuit for operating the 522 send-receive relay on 115 v. a.c.**

Miscellaneous Tips

There is a world of difference in tubes at 144 Mc. Don't rely on a tube tester — try out individual tubes, one at a time, while listening to a weak signal. Tubes that are OK on a tube tester may be completely useless on 2 meters.

The racks which hold the two units may be connected together in any way one chooses, but leave the antenna and B-plus switching arrangement as is; otherwise the receiver will come to life slowly when going from transmit to receive. Separate power supplies are the answer.

The transmit-receive relay can be operated from the 115-volt line by using the simple arrangement shown in Fig. 11-36. The 40-μfd. electrolytic charges up when the circuit is open and really snaps the relay shut when the switch is closed.

The stability of the receiver oscillator is quite good after about a 10-minute warm-up. If there is trouble with drift or frequency shift after this time, try another 9002. In one location here where the line voltage is very erratic it was necessary to use voltage regulation on the oscillator, but it is not ordinarily required.

On later units having the noise silencer it is necessary to remove resistor *254-3* from the hot filament lead of the 12H6 diode to the cathode of the a.v.c. clamper diode, or the a.c. will get into the a.v.c. line.

When removing the diode coupling transformer, *295*, also remove the two short shielded leads going to the plug on the front of the receiver, the two 0.47-megohm resistors on the power plug, *275-2* and *275-3*, mica condenser *214* on the transformer, the 0.56-megohm resistor *262-2*. The black wire with the green tracer at the junction of *275-2* and *275-3*, the yellow wire from *295*, and the green wire from *295* in the shield should be traced and pulled clear. The green wire is the grid lead, point *X* in Fig. 11-34. The black wire with green tracer is point *Y*, and the yellow wire is point *Z*.

The a.v.c. line should be disconnected from the r.f. stage when a 6AK5 is used. This is done by removing the glass-insulated lead from decoupling resistor *267-1*, in the first i.f. grid lead, and resistor *252* in the r.f. section.

The writer wishes to thank Clayton Paulette, W1IT, for the many hours of effort he has contributed to this conversion project.

— *Robert E. Fairbrother, W1PYO*

A B.F.O. FOR THE SCR-522 RECEIVER

With the increased use of c.w. on 144 Mc., the users of 522 receivers are at some disadvantage in having no beat oscillators. And even if the operator is one of those who is allergic to c.w. as a mode of communication, the b.f.o. is still a mighty handy article in combing the band for the weaker sigs. WØCCY, Council Bluffs, Iowa, uses the crystal-controlled b.f.o. shown in Fig. 11-37. The complete story is on the diagram, and values are not critical. No injection coupling was needed in his case, the second harmonic being strong enough for b.f.o. purposes with no more coupling than that afforded by the receiver wiring.

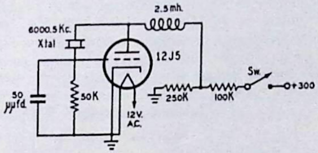


Fig. 11-37 — **Schematic diagram of the Pierce oscillator used as a b.f.o. in a 522 receiver by WØCCY. Values are not critical, and no injection coupling is required.**

GETTING ON 28 AND 50 MC. WITH THE SCR-522 TRANSMITTER

The SCR-522 is known to all v.h.f. enthusiasts as the unit that transformed the 2-meter band almost overnight, but most hams have not realized that the transmitter portion (BC-625) can be made to work on other frequencies. Two different methods of conversion for 10-meter operation are given below, and either process might be followed for use of the unit on 50 Mc. as well. — *Ed.*

—···—

In getting the 522 to work on 10 meters it was first decided to check its operation on the frequency range for which it was intended; namely, 100–156 Mc. The conversion process outlined in *CQ* for July, 1947, was followed to

attain this end. The following changes were then made to obtain 10-meter output:

1) Add a 3–13 $\mu\mu$fd. trimmer condenser across the 12A6 tank coil (*119*). This trimmer will be set at approximately 8 to 10 $\mu\mu$fd. to tune this tank to 10 or 11 meters.

2) Replace the v.h.f. r.f. chokes (*127-1, 127-2, 127-3, 127-4*) with 2.5-mh. chokes. These are the r.f. chokes in the grid circuits of both 832 stages.

3) Replace the 2-meter hairpin loop (*120*) in the first 832 plate circuit with a 10-meter coil consisting of 12 turns of No. 14 wire, ¾-inch diameter, 1¼ inches long. Connect the coupling condensers (*109-1* and *109-2*) four turns in from each end of the tank coil. If these condensers were connected at the ends of the coil it would result in excessive grid current in the final 832 stage.

4) Replace the final grid coil with another consisting of 14 turns of No. 14 wire, ¾-inch diameter and 2¼ inches long, with a ⅜-inch space at the center for the link, which consists of 5 turns of No. 14 wire of the same diameter as the tank. If it is desired to tune both 10 and 11 meters it will be necessary to add a 15-$\mu\mu$fd. air padder in parallel with the final tank condenser.

Crystals in the 7-Mc. range are used in the oscillator, doubling to 14 Mc. The second stage doubles to 28 Mc. Both 832s operate as straight amplifiers on 28 Mc. Substituting 50-Mc. coils in the 832 plate circuits, and operating the second stage as a tripler, should make it possible to obtain 50-Mc. output as well. In this case, crystals between 8334 and 9000 kc. would be employed.

— *Leonard H. Smeltzer, W4KZF*

—···—

In coverting the BC-625-AM to 28 Mc. it was thought that operation of the relays was a desirable feature, and since the d.c. supply presents no very great problem, changes were made only in the r.f. circuits, leaving the control circuits intact. This conversion process utilizes the first 832, eliminating the second, which may then be used for other purposes.

The final 832, its socket, the final coil and antenna coupling, and the tripler hairpin and its associated components are first removed. In taking out the final 832 socket remove the condenser between Pins 1 and 7 carefully, reconnecting this condenser between the now-free heater wires and ground.

Remove the 832 tripler tube from its socket, and wire a 100-$\mu\mu$fd. variable condenser in parallel with the butterfly condenser in the plate circuit of the first-harmonic-amplifier stage. The purpose of the additional capacitance is to change the stage from a tripler to a doubler. Running this extra condenser all out will permit the stage to operate on 50 Mc., when suitable crystals are used, the stage then operating as a tripler, in the original fashion.

Next a 75-$\mu\mu$fd. air padder is wired across the plate butterfly of the first 832 stage. The plate coil for this stage should have seven turns of No. 12 wire, each side of center, ⅝-inch diameter, with a ⅝-inch space at the center. The over-all length of this coil will be about 2½ inches. It should be soldered in place on the 832 butterfly condenser so that it projects over the hole which formerly housed the final 832 socket. Loop the lead that formerly carried the modulated B-plus to the final back under the chassis and connect it through the r.f. choke (previously removed from the final) to the center tap of the new plate coil. The first 832 now serves as the final stage for 10-meter work.

A three-turn loop of No. 14 wire, for antenna coupling, is connected by a short length of 300-ohm line to the two antenna terminals at the top of the transmitter. After removing the original link, a lucite rod was used as a support by inserting it through the two lower ventilating holes, and a piece of 300-ohm line was used to connect it to the antenna terminals.

Normally this completes the conversion process. Care must be exercised in tuning up the rig, and the harmonic amplifier, particularly, should be checked to see that it is operating on the correct frequency. The oscillator uses 7-Mc. crystals, doubling to 14 Mc. The two parallel capacitors added in the conversion process may be set at a point where tuning from one frequency to another may be accomplished with the regular butterfly tuning condensers.

— *Bertram D. Aaron, W4JXH;*
Clyde E. Clark

OPERATING THE BC-645 ON 420 MC.

In modifying the BC-645 for operation on 420 Mc., the basic thought in mind was to make the conversion with a minimum of changes in components and wiring from the original set. Improvements and refinements can be made in layout and circuit components for maximum performance in this new application at the expense of complicating the conversion.

Before proceeding with circuit rewiring, particularly in the receiver audio section and the transmitter modulator section, it was felt advisable to remove excess components and relays. All relays except Relay 3, all potentiometers, the small two-position switch accessible from the front of the case and shown just to the left of *VT-12* in the schematic, the 30-kc. oscillator coil and the fuse strip in front of the frequency-change relay were removed. This provided less congestion in which to work and left a neater chassis when the job was completed.

Conversion of the receiver required that the gain-control system be revamped and an audio system added which would be suitable for operation of a 'speaker or headset. In addition, it was necessary to make changes to enable one to tune to the 420–450 Mc. amateur band. The diode-detector circuit was altered to provide a source of a.v.c. voltage and to decrease loading on the last i.f. transformer. Grid-return leads of the i.f. amplifiers were lifted from ground and returned to the a.v.c. line. Since it appeared that this

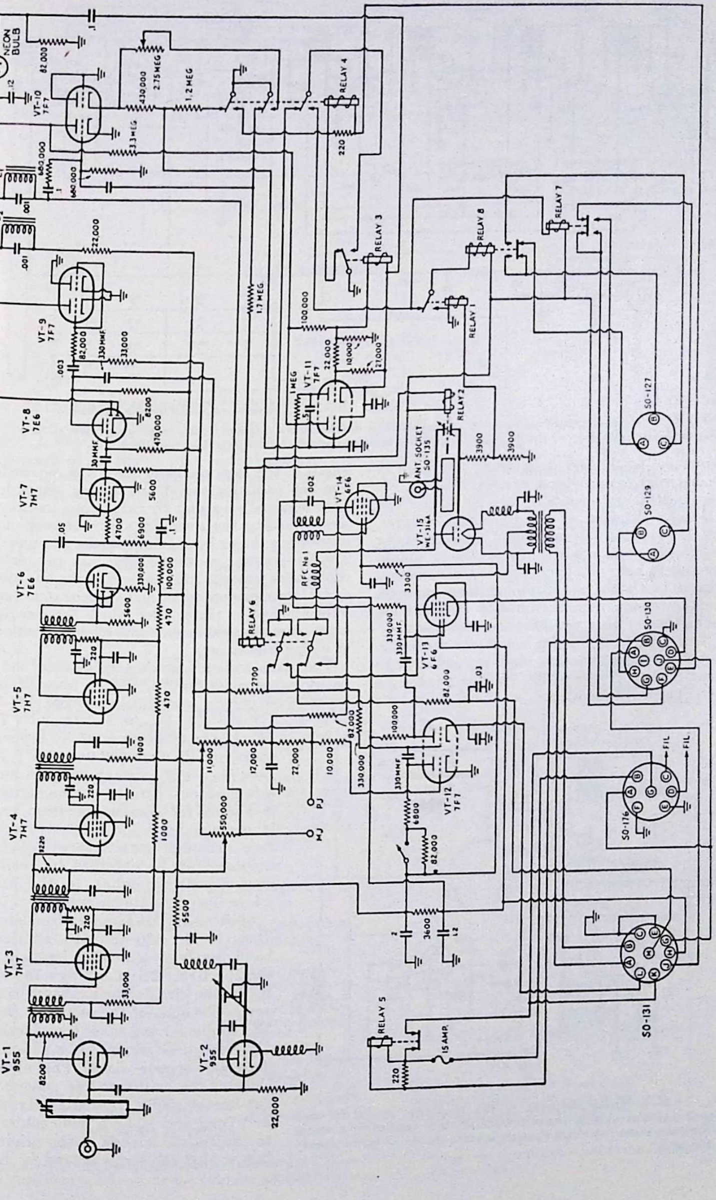


Fig. 11-38 — Diagram of the BC-645 i.f.f. unit before conversion for use in 420-Mc. amateur communication.

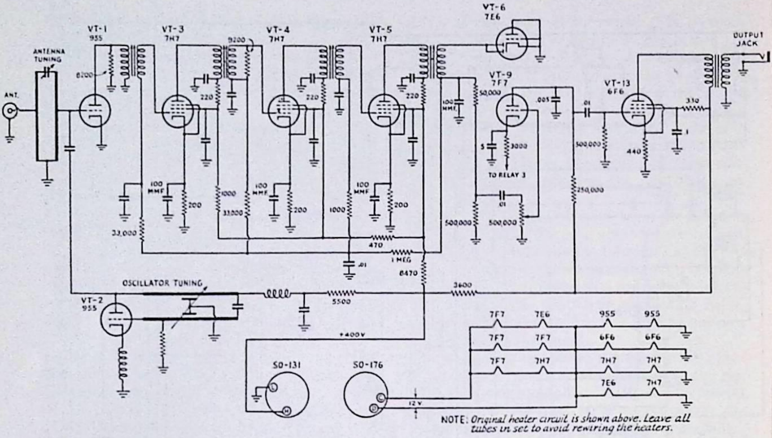


Fig. 11-39 — Schematic of the receiver as converted for 420 Mc. Two stages of audio, employing tubes already in the unit, have been added. The oscillator lines are lengthened and a.v.c. is incorporated.

equipment would find its greatest usefulness in 'phone work, no provision was made for an r.f. gain control or operation without a.v.c. The schematic diagram of the converted receiver, Fig. 11-39, shows the addition of cathode biasing resistors to provide initial bias for the i.f. amplifier tubes; however, operation was satisfactory without this initial bias. Although some improvement in residual noise is gained by biasing these tubes, the omission simplifies the conversion.

The range of the tuning condenser across the end of the antenna tuning stub was sufficient to cover the lower range to 420 Mc. and no changes were necessary here, but an increase in the length of the local oscillator lines was required. The 955 oscillator socket and tuning assembly were removed as a unit by taking out the four screws holding the assembly to the chassis and unsoldering the six leads going into the set proper. The line-shorting condenser, grid leak and plate choke were removed from the end of the line, the ends of the rods were drilled and ½-inch extensions were soldered in place, after which the components were replaced in the same relative position as in the original set.

The audio section following the detector may be as extensive as desired, with a selection of tubes for the purpose from which to choose (*VT-7*, *VT-8*, *VT-9*, *VT-10*, *VT-12* and *VT-13*). In the sets converted by the authors, one-half of *VT-9* and *VT-13* were used and gave ample gain and power output. An output transformer was added for 'speaker operation, and is recommended for headset operation although satisfactory headset volume may be obtained by resistance-capacity coupling to the first a.f. or output plate circuits.

Shifting the transmitter frequency down to the 420–450 Mc. amateur band involved removing frequency-shifting Relay 2 and adding a capacitor of the circular neutralizing type across the ends of the oscillator line. The condenser was made by soldering No. 8 flat-head screws to two ⅞-inch diameter copper disks. The extensions of the oscillator line consist of two metal strips approximately one inch long and ⅜ inch wide soldered to the capacitor ends of the original line so that the strips extend ⅝ inch

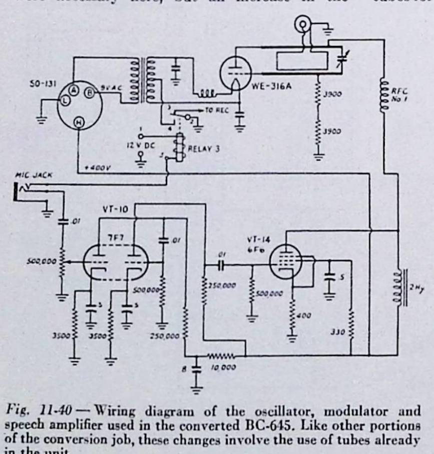


Fig. 11-40 — Wiring diagram of the oscillator, modulator and speech amplifier used in the converted BC-645. Like other portions of the conversion job, these changes involve the use of tubes already in the unit.

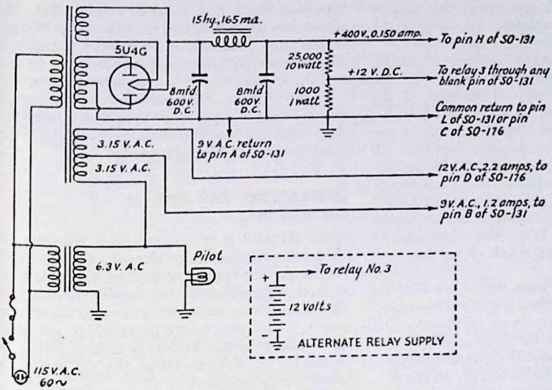


Fig. 11-41 — Diagram of the power supply used for a.c. operation of the BC-645. Two 6.3-volt windings are used in series to obtain the 12 volts required for the filament circuits. The transmitter oscillator filament transformer is supplied from one 6.3-volt winding and half of another, connected in series. Voltage for operation of Relay 3 is taken from a bleeder tap.

beyond the ends of the line rods. At 3/16 inch from the end of these strips a tapped hole was provided for the screws of the capacitor plates. The ends of the screws were slotted and screwdriver clearance holes drilled in the side of the case for access to the slotted ends of the screws. Circuit details of the transmitter section are shown in Fig. 11-40.

The modulator system is of the Heising constant-current type, using a single 6F6 as the modulator tube. Since power obtained from the 6F6 is not sufficient to modulate the carrier oscillator completely, this is one of the most inviting sections for the aforementioned improvements and refinements. However, results obtained in tests were quite satisfactory using this set-up. The speech amplifier ahead of the modulator was arranged to handle a crystal or dynamic microphone, but a carbon microphone may be used by adding a microphone transformer and a source of d.c. for microphone current. The Army T-17 microphone has been used by the authors and proved entirely satisfactory. A push-to-talk switch on the microphone is used to place the

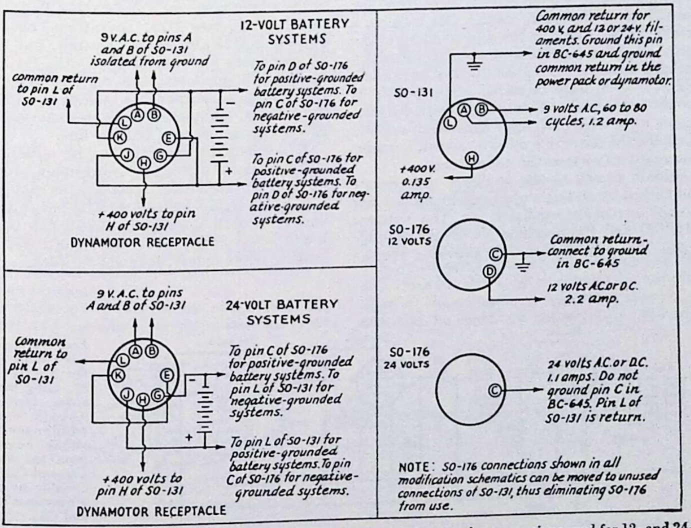


Fig. 11-42 — Power connections for the converted BC-645. At the left are the connections used for 12- and 24-volt battery operation. At the right are the connections used in a.c. operation.

transmitter in operation and render the receiver inoperative when transmitting by opening the cathode circuit of the first a.f. stage.

For mobile operation, a dynamotor supply capable of delivering 400 volts d.c. at 150 ma. and 9 volts a.c. at 1.2 amp. is required. In the conversion made and tested by the authors the dynamotor used with the original equipment was employed. Since this dynamotor required 12 volts d.c. input, no changes were made in the filament wiring, and in the design of an a.c. power supply 12 volts a.c. was provided for the filament string in the set. The schematic of the a.c. power supply is shown in Fig. 11-41. Rearrangement of the filament wiring for 6-volt operation will present no problem.

The aircraft antennas intended for use with the BC-645 consisted of vertical quarter-wave faired rods working against the frame of the aircraft; however, any antenna which can be matched to the set at or near 50 ohms should prove satisfactory.

—*John T. Ralph and H. M. Wood*

THE process outlined above is the minimum that can be done and still make the BC-645 work on 420 Mc. If long distances or nonvisual paths are to be worked the following suggestions, contributed by W1HDF, Elmwood, Conn., will make a considerable improvement in the operating range.

In its original form the mixer is operated without plate voltage. Improved performance can be obtained by running the low side of the first i.f. transformer primary to B-plus, through a decoupling network similar to that used on the following stages. A 9002 may be substituted for the 955 mixer if desired, though this requires a socket change. Regeneration may be added to the mixer stage by connecting a 15-$\mu\mu$fd. miniature variable condenser across the 10,000-ohm cathode resistor, which must be added when the B-plus connection is made. Adding regeneration makes tuning more critical, so some convenient method of tuning the mixer line must be added, to maintain sensitivity across the entire band.

Smooth tuning of the oscillator may be accomplished by adding a good-quality split-stator variable across the oscillator line. The National VHF-1D and Hammarlund VU-20 are suitable types. This control should be provided with an extension shaft and a good vernier dial. The added sensitivity resulting from the mixer changes makes some form of i.f. gain control desirable. A 200,000-ohm potentiometer may be used to control the voltage on the i.f. amplifier screens.

If 300-ohm or other balanced line is used in place of coax, hairpin loops should be installed on the transmitter and receiver in place of the unbalanced coupling loops provided.

OPERATING THE APS-13 ON 420 MC.

THE APS-13 is a low-powered transmitter-receiver designed for airborne radar service. Its frequency range covers the 420-Mc. band without alteration of the tuned circuits but, like other units built for radar and allied purposes, it contains many parts which are of no use to the amateur, and its circuits require considerable revision to make the rig useful for communication service.

The APS-13 transmitter section uses a pair of 6J6s in push-pull-parallel. Bias values are set up for pulse operation, and must be altered for continuous service. Frequency control is by means of a shorting bar which is adjusted through the front panel with a screwdriver. The receiver section has a 6J6 oscillator and a 6J6 mixer, the oscillator being tunable in the same manner as the transmitter. The mixer lines are tuned by means of screwdriver adjustment which varies the capacitance across the line. The i.f. system has five stages using 6AG5s followed by a 6AG5 detector and two video-amplifier stages using 6AG5s. Four additional tubes, two 2D21 thyratrons, one 6J6, and one 6AG5 also are in the unit, but these do not enter into use of the outfit for communication purposes, and may be removed. Other surplus components include the 28-volt dynamotor, numerous pulse transformers, a gate-forming line, and a delay line.

If a schematic diagram can be obtained it will be helpful during the conversion process, but it is not absolutely necessary, as each component is plainly marked with its part number and the instructions given below can be followed readily. So, with the screwdriver and cutting pliers handy, let's get to work.

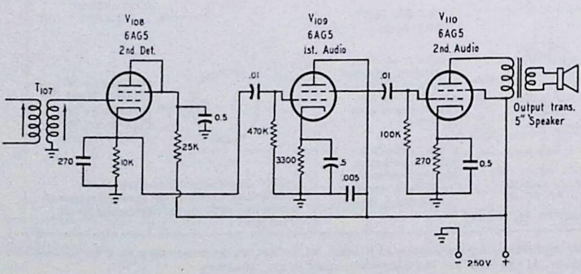


Fig. 11-43 — Revised audio amplifier for the APS-13, using the two video stages. The 0.01-μfd. coupling condensers are those removed from the unit at C_{162} and C_{208}. The 0.5-μfd. by-passes are sections of C_{157} and C_{158}.

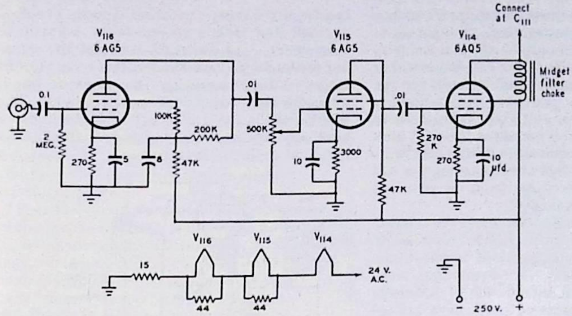


Fig. 11-44 — Speech-amplifier-and-modulator circuit suggested by WØPKD. The three tubes are used in the sockets formerly occupied by V_{114}, V_{115} and V_{116}. The socket for V_{111} is bridged by a 15-ohm resistor. Operation of the heaters is from a 24-volt a.c. source.

Remove the motor generator, D_{101}, and pulse units T_{111}, T_{112}, T_{113}, T_{114} and T_{115}. Remove resistors R_{154}, R_{157}, R_{158}, R_{159}, R_{161}, R_{162} and R_{163}. Replace R_{155} (oscillator grid resistor) with 2700 ohms. Remove R_{165}, R_{171}, C_{207}, C_{160}, and C_{208}, and connect a 47-ohm resistor in place of C_{208}, to provide screen voltage for the first i.f. amplifier, V_{103}. Remove R_{111}, R_{167}, C_{148} and C_{146}. Do not disturb the wiring to T_{116}, but remove the wire from the grid terminal of V_{116}.

Connect the i.f. screens to the output of the regulator tube, V_{117}, and remove resistors R_{142}, R_{143}, R_{144}, R_{147}, R_{148} and R_{173}. Remove J_{101} (power receptacle) and associated wiring. Remove R_{172}. Remove R_{174} from the cathode of V_{103}, the first i.f. amplifier, but leave R_{117} connected as it is.

The second detector and video stages require complete revision, so all wiring except the heater leads should be removed from the circuits between V_{108}, V_{109} and V_{110}, rewiring these stages as shown in Fig. 11-43. This is not an attempt at high-quality audio, but it does have the virtue of using some of the components left over from the removal process outlined above. The 5-inch speaker shown in the schematic diagram of Fig. 11-43 was mounted in the top of the cabinet. If desired, the interstage video transformers T_{108}, T_{109} and T_{110} may be taken apart and the cases used to house the interstage coupling components of the audio stages.

A suggested circuit for use as a speech amplifier and modulator is given in Fig. 11-44. This uses the sockets marked V_{114}, V_{115} and V_{116}, with a resistor substituted for the heater of V_{111}. The space formerly occupied by J_{101} can be used for mounting a gain control, and the adjacent space is sufficient for a microphone jack and a send-receive switch. The gain of the speech amplifier is adequate for a crystal or dynamic microphone.

The receiver gain control is left as it is, except that an extension shaft was added to provide knob control. The same may be done for the receiver and transmitter tuning adjustments. An audio gain control may be installed in place of the regulation potentiometer, if desired.

This conversion was designed to be about the minimum amount of work that can be done on the APS-13 to make it suitable for amateur use. Many refinements are possible, but the procedure outlined will provide satisfactory communication. The large number of these units available, and the low cost at surplus prices, should help to populate the 420-Mc. band in many sections of the country.

— *Joseph W. Addison, WØPKD*

GETTING ON 420 MC. WITH THE BC-788

In modifying the BC-788 for ham use, the following steps are necessary:

A well-filtered power supply capable of 250–300 volts at about 80 ma. must be supplied. Most of the components of the built-in supply will also be used. In the receiver, the high-

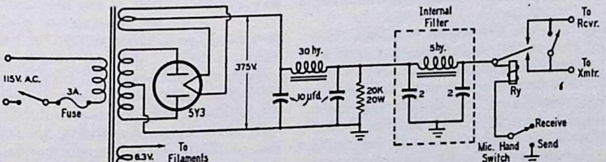


Fig. 11-45 — Power supply and control circuits for use with the converted BC-788.

frequency oscillator must be equipped with a tuning control for convenience of operation. The pulse detector is replaced with an a.m. detector, and an audio stage and loudspeaker are added. A modulator must be built for the transmitter, means provided for switching from send to receive, and (last but not least, as proved by bitter experience) the grid leak of the transmitting tube altered from 500 ohms to something like 10,000 ohms, causing the 6J6 life expectancy to increase from its previous value of about ten minutes!

Most of the conversions have left the original 800-cycle power-supply filter intact for possible use with genemotors in portable applications. An external filter must still be provided, however, as the internal inductance of 5 henrys and the two condensers of 2 μfd. each are inadequate for 60-cycle operation. In some instances improved stability has resulted from the installation of an additional 20-μfd. condenser across the output side of the internal filter.

The center line of equipment on the chassis which contains the pulse modulator, crystal oscillator and power-supply rectifier is all removed except for the rectifier tube socket, power transformer and filter components. Following Fig. 11-45, a change-over relay is provided to switch from send to receive and suitable chassis connectors and a microphone plug are mounted to bring out the external leads. A four-inch p.m. loudspeaker and its matching transformer are mounted on the panel near the left end of the chassis.

Experience has shown that it is not necessary to tune the receiver mixer circuit for ordinary operation over the amateur band. Several ideas have been tried for tuning the oscillator from front-of-panel, ranging from a semicylin-

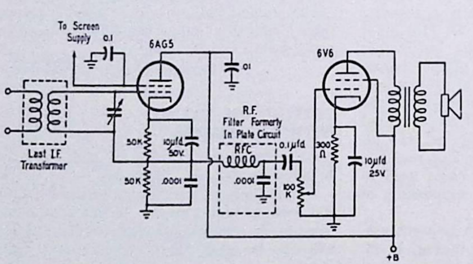


Fig. 11-46 — A simple detector-audio system for use in the receiver section.

drical slug of brass rotated in the field close to the hot end of the tuning line (as used by W6JLE) to the use of a small condenser similar to that on the mixer circuit, and finally to a mechanical extension of the line tuning screw to a knob (as used by W6DSZ, W6QT and others). The latter method gives the full range of tuning of which the unit is capable, but must be applied with care to prevent wearing out the lines. The use of some substance like Lubriplate is essential if noisy operation is to be avoided. A small dial with a geared-down indicator is convenient since about 15 turns of the screw are necessary to tune the receiver over the full range, 8 turns covering the amateur band, although this varies with some receivers. The middle of the band is found with the lines on both receiver and transmitter at about two-thirds of their full length.

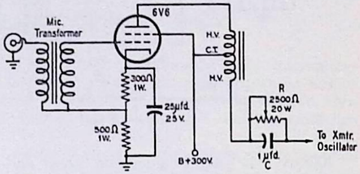


Fig. 11-47 — A suggested modulator for the BC-788.

Fig. 11-46 shows the detector and audio system used in several of the conversions. The audio output is taken from the cathode of the detector tube to avoid oscillation difficulties encountered when the load was placed in the plate circuit.

The audio output tube is a 6V6. If desired, the modulator tube may be used for receiver audio with suitable switching, but this has been thought inconvenient by most hams, and plenty of room is available for the extra tube. Also, the use of a separate output tube makes it possible to leave transmitter and receiver on simultaneously (by shorting the send-receive relay with the switch in Fig. 11-45).

The old rectifier tube socket is rewired for a 6V6 modulator tube which is driven directly by a single-button microphone as shown in Fig. 11-47. A Heising modulation system is used in which the old power transformer serves admirably as a modulation choke. To reduce core saturation the high voltage is fed in at the center tap and the modulator and transmitter fed from opposite ends of the winding.

The resistor, *R*, and condenser, *C*, are for the purpose of dropping the voltage on the oscillator tube somewhat below that of the modulator, so that the modulator plate voltage does not have to swing to zero for 100% modulation. A drop of 40 or 50 volts in *R* is ample.

The microphone current may be supplied by a small battery, or as shown in Fig. 11-47, by the cathode current of the modulator tube. In spite of the by-passing shown, the latter circuit may oscillate if the transformer is connected in the wrong polarity. In this event, the cure is of course to reverse *one* of the windings.

— *Fred D. Clapp, W6DSZ*

A MODIFICATION OF THE PE-103-A

THE PE-103-A dynamotor is designed to provide a 500-volt output with either 6 or 12 volts input. If you are content to operate always from a 6-volt source, the unit can be modified quite simply to deliver 250 volts (for a receiver) and 500 volts (for the transmitter), with change-over controlled by a remote switch. This eliminates the need for a separate power supply for the receiver.

Fig. 11-48 is a simplified schematic of the unit as received, leaving out such items as circuit breakers, field windings, dropping resistors and switch contacts which are not essential to our discussion. The dual-input-voltage requirement is met by using a special three-commutator machine having windings for 6, 12 and 500 volts. Each input commutator is provided with its own starting relay. The change from 6- to 12-volt input is accomplished by a manually-operated switch which applies voltage to the coil of only one starter relay at a time. Other sections on this switch short out filament-dropping resistors, etc. A third relay turns on the heaters and actuates the selected starting relay.

Obviously any scheme which will let us apply 6 volts to the 12-volt commutator will result in an output of about one-half normal, or about 250 volts, and will at the same time reduce the current drain from the car battery tremendously. Before the modifications described here are performed, if we switch the unit to 12 volts and put in only 6, the machine will not run because the relays will not operate.

The first step I took in the modification was to rewind the 12-volt starting relay so it would operate on 6 volts. This is a totally-enclosed relay with the cover spun on like a tin can. The relay can be opened by making hack-saw cuts through the lip of the cover at about ½-inch intervals for about two-thirds of the way around. When the resulting segments are pried up, the cover will come off and the plunger, spring, and contactor disk will fly out. After the terminals and fixed contacts are removed, the coil can be withdrawn. I unwound the coil and folded the same wire double and wound it back on, but it might be easier to wind it with heavier wire. Don't wind the coil too full. It would be satisfactory to replace the 12-volt starting relay with an auto-starter or horn relay.

In order to obtain remote control of the change-over from 250 to 500 volts, and to provide separate B+ output terminals for the receiver and transmitter, it is necessary to install an additional 6-volt d.p.d.t. relay. I found room for a miniature relay near the old 6-volt/12-volt switch. The original connections to Pins 2, 7 and 8 of the output socket were removed and the new relay wired in as shown, the coil between the common A− (hot) lead and Pin 2, one arm and its associated fixed contacts replacing the section of the 6-volt/12-volt switch which selected the desired starter relay (the normal contact to the rewound 12-volt starter and the off-normal contact to the 6-volt starter relay). The other arm is connected to the +500-volt brush and its normal contact to Pin 7 and off-normal contact to Pin 8. After these changes the terminals on the output socket are as follows:

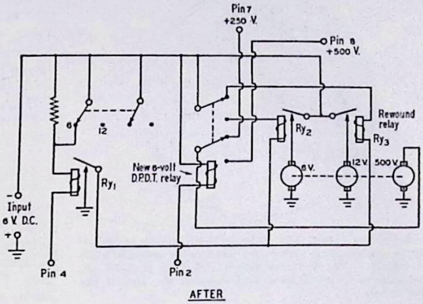


Fig. 11-49 — Rearrangement of the wiring of the PE-103-A dynamotor to permit both 250 and 500 volts d.c. to be obtained from a 6-volt source. Connections to the various terminals shown are explained in the text.

1 — A− (hot), protected by circuit breaker. Turned on all the time.

2 — Ground to transmit.

3 — A− (hot), protected by circuit breaker. Controlled by starter relay so it is on only when dynamotor is running.

4 — Ground to start dynamotor.

5 — Ground, A+, B−.

7 — B+ 250 to receiver.

8 — B+ 500 to transmitter.

Thus the transmitter and receiver filaments should be connected to Pin 3, the receiver B+ to Pin 7 and the transmitter B+ to Pin 8, the on-off switch between Pins 4 and 5, and the transmit-receive switch between Pins 2 and 5.

— *William L. Smith, W3GKP*

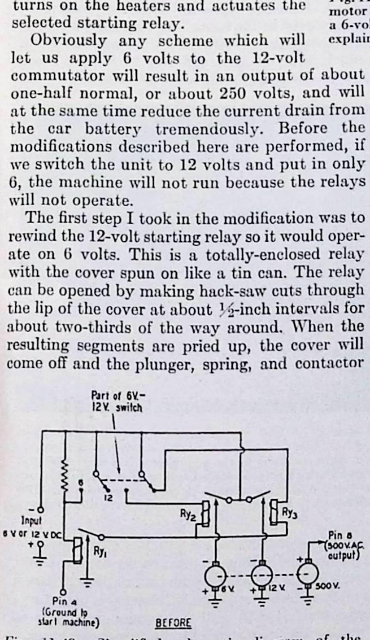


Fig. 11-48 — Simplified schematic diagram of the PE-103-A dynamotor before modification.

SUPPRESSION OF ELECTRICAL NOISE FROM PROPELLER PITCH-CHANGING MOTORS

At a Frankford Radio Club meeting, W3GHD demonstrated a means for suppressing propeller pitch-changing motor electrical noise that is so effective, so simple, and so inexpensive that I wish I had thought of it first. The method is applicable to either the 12- or 24-volt motors, and although it is necessary to remove the motor from the gear box, it is not necessary to remove the entire mechanism from an existing antenna installation.

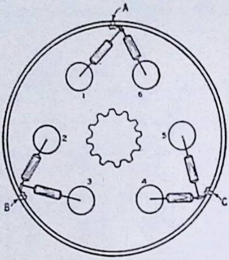


Fig. 11-50 — Noise created by propeller-pitch beam rotators can be eliminated by by-passing the brush holders to the case of the motor as shown. Points *A*, *B* and *C* are grounds made by drilling and tapping the rim of the motor case.

Materials and tools necessary include six mica capacitors, 0.002 to 0.01 μfd., three 6-32 screws, three shakeproof solder lugs to clear a No. 6 screw, a No. 35 drill, a 6-32 tap, and a husky soldering iron or small torch. The capacitors should be of the smallest possible physical thickness consistent with the requisite capacity. Centralab ceramic "Hy-Kaps" are ideal.

Remove the thin-aluminum motor cover. Most motors are held to the gear box by a threaded ring located at the joint between the motor cover and the gear-box housing, although a few motors are held by cap screws. Loosen the ring or the cap screws, supporting the motor with one hand before disengaging the last few threads. A straight axial pull will disengage the motor from the gears. Looking at the top surface of the motor, you will note six copper-surfaced brush holders symmetrically arranged around the motor shaft and its gear. Clean the top of these brush holders carefully. Midway between brushes *1* and *2*, *3* and *4*, *5* and *6*, counting around the circle from any point, drill three holes through the threaded ring which attaches the motor to the gear box, using the No. 35 drill. Tap these holes for 6-32 screws. Insert the screws with the heads inside, with the shakeproof soldering lugs under the screw heads. Now solder the capacitors between the individual brush holders and the grounds just provided as shown in Fig. 11-50. Thus, each brush holder is by-passed to ground. File the screw points off flush with the threads, taking care not to damage same. Reassemble the motor to the gear box, and go down in the shack prepared for a very pleasant surprise.

— *C. C. Miller, W2RDK*

SPEEDING UP "PROP-PITCH" BEAM ROTATORS

Those who complain that they can grow long white beards while waiting for their beams to turn around toward a choice piece of DX can heave a sigh of relief. No, you don't do it with external step-up gears, "V" belts, or by speeding up the motor until it burns out! Here's how it is done. Remove:

1) the bevel gear;
2) its thrust-bearing plate;
3) the upper case of the speed-reduction unit housing;
4) the large ring gear with the spline on it.

This last item is the first thing you will see upon removing Item 3, and is illustrated in Fig. 11-51, where it is resting to the right of the assembly, in front of the upper gear case.

Grind the teeth off the hardened splined ring gear. (Not off the splined portion, but off the *inside* of the ring!) Next drill and tap four holes in the gear carrier over which the ring gear was placed. Line the holes up with the holes that already exist in the face of the ring gear, and bolt the two together. Reassemble the whole thing and refill it with oil. You can now turn your beam at 4 or 5 r.p.m. if you want to. To reduce this to a more-comfortable 2 r.p.m. it is only necessary to reduce the voltage applied to the motor. Don't worry about the slight reduction in power caused by "short-circuiting" one of the several planetary-gear sets. It will still have enough steam to "rotate the house should the beam get stuck."

— *David G. Vanderhoek, W2VLL*

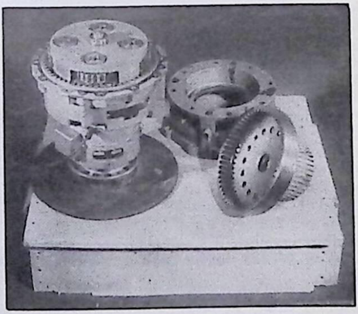


Fig. 11-51 — The "works" inside a propeller-pitch beam rotator. The ring gear mentioned in the text is shown at the right, in front of the upper gear housing. The gear carrier, which is to be drilled and tapped, is still fastened to the top of the assembly. After modification, rotation speeds up to 5 r.p.m. may be obtained with these motors.